

HIGH TECHNOLOGY BUSINESS

OCTOBER 1987

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U.S. ROBOT MAKERS TRY TO BOUNCE BACK

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GMF Robotics

President
Eric Mittelstadt



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It's long been thought that even the best of technology eventually becomes obsolete. A notion that we at Hayes could never really understand. And certainly never accept. So in defiance of it, we created the V-series Smartmodem 9600™ and V-series Smartmodem 2400™ Modems that actually get better as they get older. Because they not only incorporate the most intelligent features found in modems today, they also possess the capability to provide a long-term growth path into the communications environments of tomorrow.

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Synchronous and asynchronous communications modes as well as simulated full-duplex employing advanced CCITT V.32 trellis code modulation and fast turnaround ping-pong technology are also part of the package. Plus you'll get the capability to link up with a range of networks, including SNA. And soon V-series technology will offer an X.25 PAD option to further accommodate network environments of today. And the future.



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V-SERIES SMARTMODEM 2400

With adaptive data compression this modem can achieve an effective throughput of up to 4800 bps. Of course, it too offers point-to-point error control, forward error correction, data flow control, automatic feature negotiation and synchronous as well as asynchronous communications modes. And like the V-series Smartmodem 9600, it can link up with a wide range of networks, such as SNA, and be enhanced with an X.25 PAD option.

V-series modems come in stand-alone versions and internal versions (V-series Smartmodem 9600B™ and V-series Smartmodem 2400B™). Internal versions are bundled with our powerful new Smartcom III™ communications software.

And as yet another rebuttal to the argument for obsolescence, we developed the V-series Modem Enhancer.™ A separate stand-alone device that will upgrade current Smartmodem 1200™ and Smartmodem 2400™ external modems to the new standards set by the V-series products.

A closer look at the V-series product line will reveal to you a revolutionary technology designed to be the beneficiary of time, not its victim. So contact your Hayes Advanced System Dealer or call **800-635-1225** for the one nearest you.



Galaxy II and INTELSAT satellites are now transmitting U.S. television programming to Japan using a hookup provided by Hughes Aircraft Company. NHK, Japan's leading television broadcaster, transmits from its New York studio to Hughes' Brooklyn, New York ground station. The signal is sent to Hughes' Filmore, California ground station via Galaxy II, and then beamed to an INTELSAT satellite over the Pacific Ocean. The signal is then relayed to a Japanese ground station north of Tokyo and fed into the local NHK studio. The daily broadcasts include segments of major U.S. and European news and entertainment programs, plus live on-the-scene reports from NHK bureaus in North America and Europe. Galaxy II is one of three domestic satellites owned and operated by Hughes Communications, Inc., a subsidiary of Hughes.

Hughes is reducing software costs to customers by up to 40 percent via the comprehensive Hughes Software Engineering Environment (SE²®). SE² is an integrated system of computers, workstations, communications, specialized software tools, and comprehensive training and user support. The system lets engineers and managers focus their efforts on software development, quality, and productivity, without having to supervise a complex computer facility. Operating successfully for several years on many diverse domestic and international real-time, computer-controlled projects, SE² provides a complete life cycle of software development and support. Hughes is continually updating SE², including a 1986 upgrade to comprise a total Ada® capability.

Gate array technology improves the airborne radar performance and increased operational modes for the U.S. Air Force F-15. Pioneered by Hughes, gate arrays are used extensively in the new Hughes APG-70 radar system. They provide the capability to increase the speed of the system's programmable signal processor (PSP) to more than 34 million complex operations per second, five times faster than its predecessor. Gate array technology enables the APG-70 to incorporate operating modes that were unavailable in earlier tactical airborne radars, greatly enhancing the entire F-15/APG-70 weapon system's operational capabilities. The system was developed under contract from McDonnell Douglas, which builds the F-15 for the U.S. Air Force.

Advanced composites of graphite and Kevlar have been evolving as replacements for metals. These composites have a unique advantage over metal because they do not expand or contract when exposed to heat or cold, and therefore are unaffected by the temperature extremes of space. Hughes has been using graphite composites in the construction of spacecraft since the early 1970's, including the Leasat satellites built to provide communications for the U.S. Navy. Until now, however, graphite has been difficult to mold into complex shapes, but Hughes has made it possible to produce complicated new forms. The company is developing intricate spacecraft coupling rings seven feet in diameter in which graphite composites will replace aluminum.

Hughes Ground Systems Group is applying its airspace management experience to the exciting challenges of worldwide air traffic control. These systems will be designed to ensure service 24 hours a day, 7 days a week. They will support distribution of processing among multiple computers linked via local area networks. The many challenges include design and development of hardware and software to support advanced display and man-machine interface technology, and using satellite technologies for future ATC applications. To help design the next generation of air traffic control systems, send your resume to Hughes Ground Systems Group, Employment Dept. S2, P.O. Box 4275, Fullerton, CA 92634. Equal opportunity employer. U.S. citizenship required.

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HIGH TECHNOLOGY BUSINESS

FEATURES

18

U.S. ROBOT MAKERS TRY TO BOUNCE BACK
 Companies that rushed into robotics when everyone was buying are abandoning the field to smaller, more focused robot makers.

27

SCANNER STANDARDS: WHO WILL EMERGE?
 With the surge in desktop publishing, companies are trying to become leaders in their respective market niches.

34

MONEY MACHINES OUTGROW BANKING
 Automatic teller machines are evolving into networks of terminals that sell everything from full tanks of gas to theater tickets.

38

PHONE COMPANIES GAMBLE ON TECHNOLOGY
 The independent telephone companies are trying to grow by diversifying. So far, most have found nothing but headaches.

42

INTERVIEW GM vice-chairman Donald Atwood discusses the new auto industry and the role technology plays in shaping it.

COLUMNS

13

COMPUTERS Computer systems that provide their own backup have profited from businesses that operate around the clock.

15

JAPAN WATCH Frustrated by digital audio tape's poor sales record, makers may shift their focus to the data-storage market.

17

THE LAW Suits against software

companies could cut the number of discount look-alikes.

MARKETWATCH

47

NEW COMPANIES An update on where the startups are.

49

JOINT VENTURES The collaborations that are shaping the future.

49

CONTRACTS AWARDED A record of companies and how much they'll make.

51

MERGERS & ACQUISITIONS Who's buying whom and for how much.

51

RESEARCH REPORTS The latest studies for businesses.

53

THE LEADING 100 A guide to high-technology stock performance.

DEPARTMENTS

5

EDITOR'S NOTE

6

LETTERS

8

NEW DEVELOPMENTS Superconducting launches startups; NASA starts spending \$4.1 billion; network expands choices in electronic mail.

59

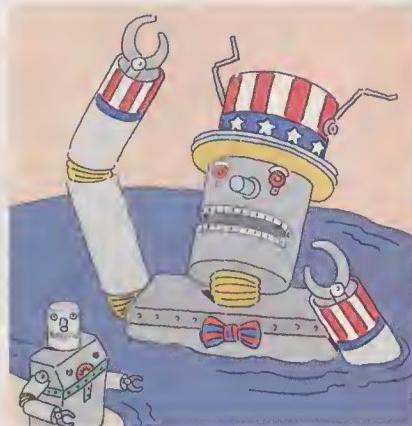
NEW PRODUCTS Computer hardware and software, manufacturing equipment, and consumer items.

63

COMPANY INDEX

64

PERSONAL TECHNOLOGY Wall-socket networks; desktop VCRs; verbal-command phones.



The new robotics: struggling to change, p. 18.

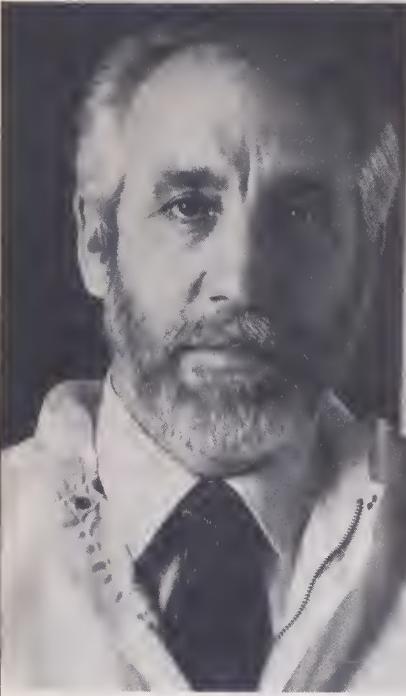


Phone companies' diversification woes, p. 38.



Scanner applications skyrocket, p. 27.

Cover photograph by Kevin Horan



Dr. James Holm-Kennedy
Professor
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"The character, drive and sheer talent of these Hawaii graduates is just outstanding. Many people live in Hawaii for the personal rewards. For me, it's the professional satisfaction."

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MTP's design has won the prestigious "Golden Nugget Award" from the Pacific Coast Builders Conference. A development of Castle & Cooke, MTP is itself part of a planned residential and commercial development which already provides homes for 26,000 people.

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1	31	81	81	121	151	181	211	241	271	301	331	381
2	32	82	92	122	152	182	212	242	272	302	332	382
3	33	83	83	123	153	183	213	243	273	303	333	383
4	34	84	94	124	154	184	214	244	274	304	334	384
5	35	85	85	125	155	185	215	245	275	305	335	385
6	36	86	96	126	156	186	216	246	276	306	336	386
7	37	87	87	127	157	187	217	247	277	307	337	387
8	38	88	98	128	158	188	218	248	278	308	338	388
9	39	89	99	129	159	189	219	249	279	309	339	389
10	40	70	100	130	180	180	220	250	280	310	340	370
11	41	71	101	131	181	181	221	251	281	311	341	371
12	42	72	102	132	182	192	222	252	282	312	342	372
13	43	73	103	133	183	193	223	253	283	313	343	373
14	44	74	104	134	184	194	224	254	284	314	344	374
15	45	75	105	135	185	185	225	255	285	315	345	375
16	46	76	106	136	186	196	226	256	286	316	346	376
17	47	77	107	137	187	197	227	257	287	317	347	377
18	48	78	108	138	188	198	228	258	288	318	348	378
19	49	79	109	139	189	199	229	259	289	319	349	379
20	50	80	110	140	170	200	230	260	290	320	350	380
21	51	81	111	141	171	201	231	261	291	321	351	381
22	52	82	112	142	172	202	232	262	292	322	352	382
23	53	83	113	143	173	203	233	263	293	323	353	383
24	54	84	114	144	174	204	234	264	294	324	354	384
25	55	85	115	145	175	205	235	265	295	325	355	385
26	56	86	116	146	176	206	236	266	296	326	356	386
27	57	87	117	147	177	207	237	267	297	327	357	387
28	58	88	118	148	178	208	238	268	298	328	358	388
29	59	89	119	149	179	209	239	269	299	329	359	389
30	60	90	120	150	180	210	240	270	300	330	360	390

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laid off almost one-third of its workers during the last year. GE shut down its Orlando robot-making operation earlier this year. Westinghouse consolidated its operations into another division, causing massive layoffs. In many cases, these companies' customers have simply bought all the robots they will need for the foreseeable future.

But the wounds are being treated; robot makers are learning to temper optimism about new technology with clear-headed business sense about the ways in which it can best be used. In this month's cover story ("U.S. Robot Makers Try to Bounce Back," p. 18), senior editor Herb Brody takes an in-depth look at how the industry is reassessing its future and trying to find rays of hope in a generally gloomy landscape.

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Technology's Risk Factor

Making business decisions that involve technology often means high risk. Sometimes it's because people are led to expect more than a new technology actually delivers. Sometimes it's because they draw improper conclusions from the direction in which a particular technology seems to be headed. And sometimes it's because a market has matured sooner than anyone initially expected.

A few years ago, robots and the robotics industry were expected to revolutionize automation. However, the vision of robots replacing people at work or cleaning their houses simply hasn't materialized. Companies that followed the vision and ignored the realities of the marketplace got hurt, some very badly.

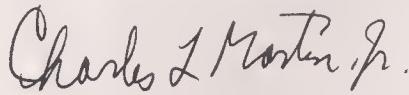
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■ Space station condensation

WELL DONE, and thank you for your splendid article, "Space Station Business," by Peter Gwynne in the August issue. Many of the participants in the project must appreciate the difficulty involved in condensing the space-station story, which could easily have filled an encyclopedia. The article was enlightening due to the candid comments and discussions by many of the key players—people with whom we, as a small business, have little or no contact. It is quite difficult to gain insight into the overall activity, and much of our planning is based on conjecture.

Almost every aspect of space-station design and planning has two or more schools of thought on how it should be done. Our discipline, aerospace robotics, is one of the most hotly argued. We, of course, believe that aerospace robotic systems could spell success in building and maintaining the space station.

Over the next 20 years, aerospace robotics will yield a wealth of beneficial offshoots for earthbound automation systems. For example, thought-controlled aerospace robots may materialize that could give elderly or disabled people more independence. Artificial limbs may well become more lightweight and efficient.

The question is, will we be the world leaders and producers in this arena, or are we to buy this technology from overseas? If we do not use our knowledge in the space station, others will.

J.B. Kader
President

Kader Robotics Corp.
Birmingham, Alabama

■ The ISDN market

DWIGHT DAVIS' article in your August issue on the integrated services digital network (ISDN) highlighted a disturbing characteristic of ISDN development in the United States. He seems to infer that lack of a market for ISDN is attributable to the fact that the United States lacks a government-driven telecommunications monopoly.

As a supplier to business telecommunications users, I disagree. The market

for ISDN is being created by telephone companies and their suppliers. Despite the breakup of the Bell System, local telephone companies retain de facto monopolies over huge operating territories. They continue to exert legal and technical pressures to force the Federal Communications Commission and the federal court overseeing their operations to redesign the technical separation between their equipment and customer-owned equipment. If they are successful, they will provide proprietary equipment based on standards they defined to lock out competition.

The ISDN system, as specified by telephony committees in the U.S. and abroad, extends the monopoly all the way to the business office desktop without the telephone companies' incurring terminal or control costs. It also will provide the technical means to increase billable transport traffic. And, it will force non-telephone-company vendors to deal with a manufacturing and ISDN "non-standard," a disadvantage to outside vendors simply by the weight of the telephone companies' pressure.

Those business and residential customers who are supposed to be the beneficiaries of ISDN have contributed almost nothing to the dialog on ISDN. Communications managers at the largest multi-location corporations—ISDN's primary targets—are lukewarm to the concept. Some regard ISDN as the telephone companies' attempt to gain control of communications now handled by privately owned networks.

Mr. Davis' article correctly points out that telephone companies will offer "economic incentives" to persuade businesses to sign up for ISDN-provided services. It's likely that ISDN services initially will be offered to businesses at prices below cost. Other services, including residential service, basic business service and private lines, will be priced to subsidize creation of "market demand" for ISDN. This strategy was called cross-subsidization when AT&T used long-distance revenue to help cover costs of providing local telephone service. It is only an "economic incentive" when a \$10-billion telephone mo-

nopoly does it for its own purposes.

Your readers should bear in mind two nicknames ISDN has inspired in the telecommunications community: "Integrated Services Users Don't Need" and "I Still Don't Know."

*Howard J. Gunn
Vice President of Marketing
Gandalf Technologies Inc.
Wheeling, Illinois*

■ Chinese cows

I ENJOY your magazine and the wide array of subjects that you cover. However, on page 38 of the August issue, there seems to be an error in the comparison between the milk production of Chinese diary cows and Holsteins in the United States. If Chinese cows do produce about half as much as U.S. Holsteins, then the figure for Chinese cows should be 6,000 pounds and not 600.

*Nils Ladderud, Vocational Director
Kent Public Schools
Kent, Washington*

■ Editor: *The typical Chinese cow produces about 600 pounds of milk per year, as published. However, Holstein cows in the United States deliver close to 14,000 pounds—far more than twice as much—according to the Holstein Association in Brattleboro, Vermont.*

■ A question of degree

WITH SADNESS I have noticed that international units are not used in a magazine that focuses on the future of the international community. For example, the use of Fahrenheit degrees instead of Kelvin or Celsius in your article on superconducting (July 1987) hinders the stature of your publication. I would like to be able to discuss these technological breakthroughs with my children, who will probably never hear about imperial gallons, pounds, or degrees Fahrenheit.

*G. Garrido
Canadian Liquid Air Ltd.
Montreal, Canada*

We welcome comments from our readers. Address letters to Editor, HIGH TECHNOLOGY BUSINESS, 214 Lewis Wharf, Boston, MA 02110. We reserve the right to edit letters for length and clarity.

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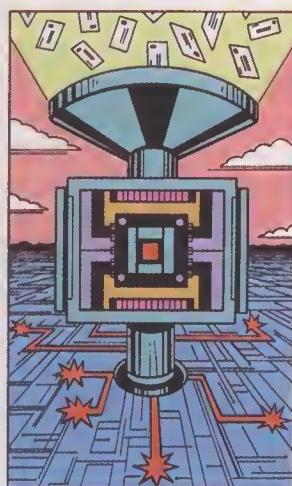
THE USE of electronic mail has traditionally been limited because customers could communicate only with other subscribers of a particular system. Electronic-mail refiling services, which send a message from the sender's system to a central database that transfers it to another system and resends it, have connected only a handful of services.

Now comes a system called DASnet, which links 18 different electronic-mail services, including MCI Mail, Dialcom, and Easylinx.

Russell Briggs, president of DA Systems—the software company that created DASnet—explains that the company set up DASnet for its own customers, but then recognized the system's commercial potential and began selling it separately. Several thousand customers have signed up so far.

DASnet charges companies a \$450 setup fee and \$80 per month, plus usage. Individuals pay \$4.50 per month, plus usage. Transferring a 2,000-character message—approximately the length of a one-page business letter—costs about 50 cents.

Electronic-mail refiling may have a limited time to establish itself, however. The Consultative Committee on International Telephony and Telegraphy set the X.400 international standard in



1984 to create a universal answer to the problem of incompatibility among the various electronic-mail systems on the market.

Jay W. Fitzpatrick, president of Wiltek in Norwalk, Conn.—another electronic-mail refiling company—acknowledges that if the X.400 standard achieves acceptance worldwide, "there would be no need for us. However," he says, "it is unrealistic to think this will happen in my lifetime."

Superconductors Spur New Ventures

AS RESEARCH on superconductivity continues at a fervid pace, several commercial ventures are now getting underway. In the lead are companies making superconducting wire and tape.

These companies are de-

veloping techniques for turning the brittle superconducting ceramics into more flexible strands that can be fashioned into usable forms. One approach is to put powdered ceramic superconductor material into a thin tube, draw the tube into a fine hollow wire, then heat it to fuse the ceramic granules inside. Illinois' Argonne National Laboratory will use this approach, financing the launch of a new company through its \$380-million venture-capital arm Arch Development in Chicago (Arch is a joint undertaking with the University of Chicago). The Japanese electronic giant Toshiba also uses this method, but rolls the tube into a tape.

Another startup, American Superconductor of Cambridge, Mass., makes tape from the metal alloys before they are oxidized to form the superconducting ceramic. Meanwhile, at its lab in Navesink, N.J., Bell Communications Research is preparing thin films for use in superconducting electronic devices. Rapidly pulsed lasers vaporize the ceramic so it can be deposited on a substrate material. In Austin, Tex., Microelectronics & Computer Technology is setting up a consortium to develop superconductors for electronics.

Indeed, the commercialization of superconductors is becoming such a priority that President Reagan has proposed a \$150-million federal initiative providing gov-

- NASA prepares \$4.1-billion budget for information technology
- Talking workstations come of age in three new products
- Accident could lead to new glaucoma drug

ernment funding, primarily from the Pentagon.

The most immediate payoff in superconducting will probably go to producers of the raw materials used to make the ceramics. For instance, Rhone-Poulenc of Monmouth Junction, N.J., has acquired a yttrium mine in the Adirondack Mountains in hopes that the new superconductors will stimulate demand for that element.

A Quiet Revolution

AS AMERICA'S infrastructure ages, the concrete surfaces of bridges, roads, and parking garages demand renovation. But because the vibration from jackhammers can pulverize more than the concrete being drilled, the market for alternative methods of removing concrete is expected to grow.

Several companies have packaged high-pressure water jets in portable form, for stripping concrete from structures without causing further damage. Bill Graham, director of international sales for Admac, a \$12-million public company in Kent, Wash., says its \$450,000 Hi-Flow portable water-jet cutter squirts 23 gallons of water per minute through a nozzle at 25,000 pounds of pressure. Pressures as high as 60,000 pounds are possible, Graham says, but he points out that European competitors tend to use more water at lower pressure.

Although critics complain the machines are still too cumbersome, Graham says his company has already sold a dozen Hi-Flows. Admac will sell or rent the product to construction companies, but also works in joint ventures, providing expertise along with the equipment.

Industry Alliance Boosts Optical Disks

OPTICAL-DISK makers are fast developing products that store computer data. However, they must still convince computer users to trade their familiar magnetic tapes and disks for the optical medium, which works like the compact disks popular with music lovers.

To do this, Robert U. Spengler, marketing vice president of Philips and Du Pont Optical (PDO), proposes an industry-wide alliance to unite companies around three goals: standards, education, and research.

Specifically, he says, the industry needs to promote the technology, set standards to make all optical-storage products compatible, educate the computer community about the advantages of storing information optically, and conduct basic research.

But despite the obvious



New alliance pushes optical data storage for computers.

PHILIPS AND DU PONT OPTICAL

advantage of strength in numbers, Spengler says that U.S. companies generally shy away from alliances, fearing antitrust action from the government. Thus, the first sales job for alliance supporters is to convince others to join—an effort now beginning with vigor. Kodak and its Verbatim subsidiary have already voiced support for the concept. However,

neither IBM nor Digital Equipment Corp. has committed to the idea, and Spengler acknowledges that their participation will be critical.

At stake is an optical-storage market that PDO predicts will reach \$4 billion by the early 1990s. But, Spengler warns, "If an alliance is not formed, the market won't achieve its potential."

Technology Marts on the Rebound?

THE CONCEPT of a technology "mart," where many companies display their information-age wares in permanent showrooms, is receiving renewed support.

The first such facility—Dallas' Infomart—suffered from bad timing: It opened in January 1985, on the eve of a major slowdown in the computer industry, and the space

filled slowly. Infomart now has 80 exhibitors, occupying more than half of the 900,000 square feet available.

Working on the principle that Infomart is half full rather than half empty, developers in Atlanta began to build a similar facility in August. Called Inforum, it is slated to open 600,000 square feet of exhibitor space in the summer of 1989. Like Infomart, Inforum will provide a place for business people to

buy computers and telecommunications equipment, much as consumers patronize the local shopping mall. Inforum's developers—Equitable Real Estate and The Portman Companies—cite the center's convenience to downtown and the airport as an edge it will have over the relatively isolated Infomart.

Inforum will emulate one of Infomart's most successful features: "executive briefings," in which companies describe particular products, such as local-area networks, to a prospective customer. In addition, Inforum will draw upon faculty from Georgia Tech University for technology seminars; these (presumably unbiased) tutorials should help business people make smarter buying decisions.



Atlanta's Inforum.



Dallas' Infomart.

LEFT INFORUM; RIGHT INFOMART

NASA Slices \$4.1-Billion Pie

NASA HAS begun handing out \$4.1-billion worth of contracts for information-technology projects scheduled through 1991, and the largest has gone to Grumman—its biggest NASA deal since the Apollo lunar module in the early 1960s.

NASA, which spends about 10 percent of its annual budget on the hardware, software, sensors, and robotic systems it needs to support space missions, plans to buy more information technology over the next five years than almost any other federal civil agency, according to the Office of Management and Budget.

Grumman has gobbled up the largest slice of pie to be cut so far—an \$841-million contract with a \$406-million rider for systems, engineering, and integration. Lockheed is currently second, with a \$141-million, nine-year software support contract, at least \$60 million of which

NASA's information-technology spending: 1987-1991

Category	Number of projects	Estimated	% of total
Aeronautical research and technology base	126	\$856.9 million	20.96
Space transportation operation program	45	\$701.4 million	17.15
Space science and applications	73	\$607.2 million	14.85
Shuttle production and operations program	55	\$549.5 million	13.44
Space and ground network communication systems	44	\$357.3 million	8.74
Launch and landing operations	13	\$297.4 million	7.27
Resources and program management	38	\$215 million	5.26
Space station	22	\$176.9 million	4.33
Tracking and data acquisition	12	\$140 million	3.42
Flight operations	15	\$118.5 million	2.90
Other	6	\$32.2 million	0.79
Orbiter	7	\$30.2 million	0.74
Space research-and-technology base	3	\$3.9 million	0.09
Life science	1	\$2.4 million	0.06

GAO/IMTEC-87-20 report

will go to Planning Research Corp. of McLean, Va. Planning Research will provide its Automated Product Control environment, which speeds software development by handling many routine functions.

Ford Aerospace will get a piece of both the Lockheed contract—\$10.5 million over five years—and the Grumman contract, which awards Ford Aerospace \$160 million over the next 10 years. Wyle Lab and Booz, Allen, and

Hamilton also will do work for Grumman.

Boeing's \$40-million contract for technical and management information is the third largest awarded by NASA in the current five-year spending plan.

Hands-off Experience

ANYONE WHO has ever wished for an extra pair of hands to work with their computer while performing other tasks might be

interested in the new voice-recognition and speech-synthesis devices now available. These devices respond to verbal instructions from the operator—even if he or she is not speaking clearly or is obscured by background noise (as much as 85 to 113 decibels, depending on the system—the noise level in a subway train is about 90 decibels). The products also use text-to-speech capabilities to prompt the user verbally for additional information or commands and to confirm that they have received data.

The new voice workstations generally consist of a voice-recognition and synthesizer unit, associated software, and a headset.

The devices allow workers to input and receive data and instructions without ever removing hands or eyes from the task. A quality-control worker, for example, could tell the computer where defects occurred, listen to a synthesized confirmation that the data had been received, and move on to new tasks, all without looking away from the production line. Other potential uses include laboratory research, financial trading, postal metering, inventory control, and CAD/CAM design.

Companies making the devices include Intel, Westinghouse, and Voice Industries Corp. of Morristown, N.J. Although the devices must be trained to recognize a single

operator's voice, vocabularies of 100 to 1,000 words are available, depending on the system.

A single-user station of Voice Technologies' Verbex 5000, which works with a personal computer, costs \$5,900. Intel's iSWS 210 workstation sells for \$10,000 to \$11,000, and the Westinghouse Series 100 can run to \$15,000 per station.

The larger companies say their products offer better performance, bigger vocabularies, and special features, as well as tougher designs that withstand industrial dirt and temperatures. Intel, for example, uses sealed bubble-memory units instead of more vulnerable floppy disks to store data.



KEITH BENDIS

Defense Department Shops for Prototypes

THE DEFENSE Department's Advanced Research Projects Agency (DARPA) has decided to shell out \$50 million to \$200 million annually on advanced-weapons-on-system prototypes. In the past, the agency has largely financed research-and-development projects that demonstrated a technology's possibilities. Prototypes, on the other hand, are "designed to fulfill a specific military mission," says Dr. Albert Brandenstein, head of the recently created prototype-program office.

Brandenstein says the emphasis in awarding contracts will be on the most innovative approach rather than the lowest bid. Programs

will probably be based on advanced, high-risk/high-payoff technologies that the agency has already supported. For example, DARPA-sponsored research in electromagnetic antitank guns, which launch projectiles by magnetic fields rather than exploding gases or rockets, might be applied to an armored-vehicle prototype. But this is only one of many potential programs on DARPA's shopping list.

The new prototype program is expected to provide another source of income for the companies already heavily involved with defense development, including such industry heavyweights as General Dynamics, Martin Marietta, TRW, and General Electric. DARPA has already awarded two contracts, both

classified, and a third is pending approval from a special council that includes the Pentagon's Undersecretary of Defense for Acquisition.

Accident May Create New Glaucoma Drug

NOT LONG AGO, an Arkansas man spilled some juice in his eye. That minor accident could lead to a better treatment for glaucoma, the vision disorder caused by pressure inside the eye that affects many elderly people.

Chemists at the Georgia Institute of Technology have isolated the active ingredient in the juice, which had an unexpectedly beneficial effect on the man's glaucoma. The substance dramatically re-

duces eyeball-fluid pressure in animals, according to John Fraser, a licensing executive at University Technology Corp (UTC) in Durham, N.C., the university's licensing agent. Equally as important, pressure remains low as long as 72 hours; today's glaucoma drugs work for only a few hours.

The substance—its identity remains a secret until its developers have filed for patents—could capture a significant share of the ophthalmological-pharmaceutical business. In 1986, the worldwide market for such drugs totalled \$440 million, according to UTC.

The drug has yet to be tested on humans, says Fraser, and remains at least two to three years away from market.

ALSO WORTH NOTING



Chinese launch U.S. sales effort.

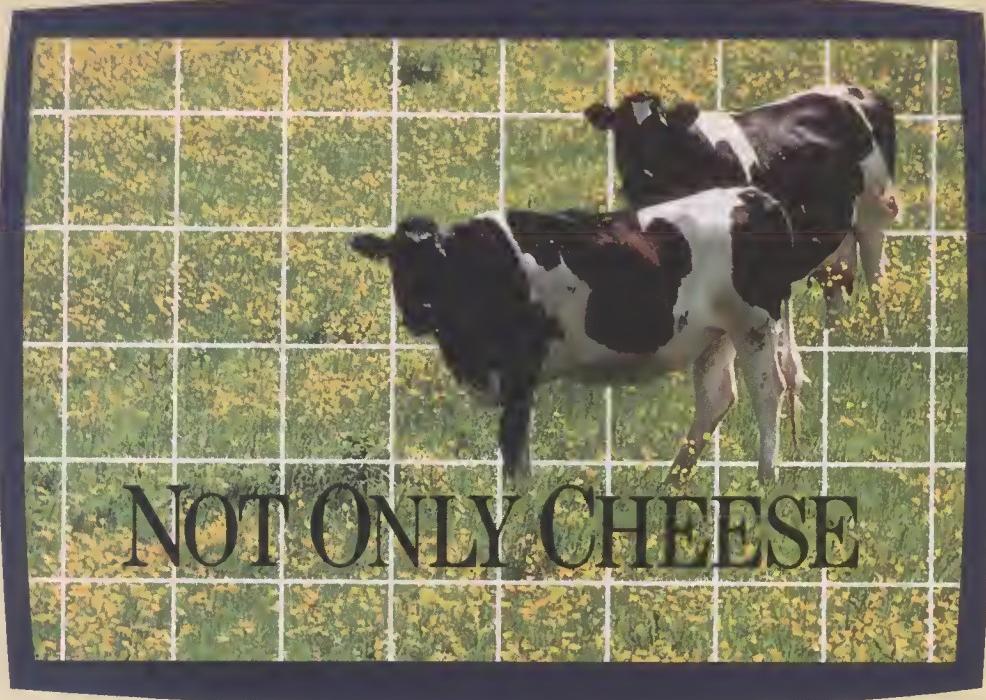
■ China has become only the third country, after the United States and the Soviet Union, to offer Western scientists the ability to launch recoverable satellites. Representatives of the China Great Wall Industry Corp., which operates China's Long March Rocket program, spent the summer on a U.S. tour pro-

moting the new Scientific Exploration and Technical Experimentation satellite platforms. Since 1975, China has successfully sent up and recovered eight of its own satellites without a failure, and a French payload was launched and recovered in August. One key use for the recoverable vehicles, which can weigh more than 300 pounds, will be to test material-processing techniques under microgravity conditions and then return the materials to earth for examination. The company hopes to sign its first U.S. customers for launch dates next year. China guarantees that it will not inspect any satellites launched under the program.

■ The gap between Japanese and U.S. robotics technology is based on knowledge, not culture. That's

the conclusion reached by Susan Hackwood and Gerardo Beni, co-directors of the Center for Robotics Systems in Microelectronics at the University of California, Santa Barbara, after two years of research. To help close the gap, the researchers have begun "Bridge from Japan," an exchange program that brings Japanese researchers, with their expertise in "mechatronics" (electronically controlled mechanics), to the university. Already a number of Japanese scientists have conducted research there, and a few American postdoctoral students—after learning the Japanese language—have done the same at universities and companies in Japan. The exchange should help stimulate development of the next generation of robots.

■ Researchers at the Enrico Fermi Institute at the University of Chicago are developing a new scanning transmission electron microscope that promises to give scientists their first look at atomic particles measuring less than an angstrom, or one ten-billionth of a meter. The new microscope, which uses an IBM 4381 computer to control its innovative image-correction system, will increase resolution two to three times over today's best instruments. The added resolution will let researchers see objects about half the size of a hydrogen atom; current microscopes can see only the largest atoms. After being turned on next year, the new microscope is expected to find initial applications in biophysics, helping scientists define protein structure.

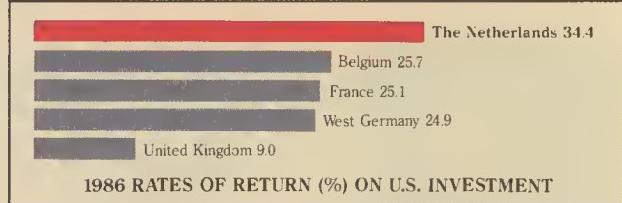


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A Rise in No-Fault Systems

**CHANGING BUSINESSES FIND NEED
FOR 24-HOUR COMPUTERS**

■ By Clinton Wilder

IN A WORLD of round-the-clock securities trading and other activities that demand a constant flow of data, a computer that operates continuously without faltering is clearly desirable. As a result, businesses are turning to what is called fault-tolerant computing. Increased interest in fault-tolerant machines is part of the market for on-line transaction processing, which delivers such services as bank withdrawals or airline reservations to the user on demand. The more automated a business becomes, the more transactions it generates that need on-line processing.

Although only two computer manufacturers have really tapped the market potential of fault-tolerant computing, both have exhibited the storybook growth of the proverbial high-tech high flyer.

Tandem Computers of Cupertino, Calif., and Stratus Computer of Marlboro, Mass., are competitors with a lot in common. Although Tandem is older and larger, both companies have grown up fast. Most important, both companies sell a technology that is extremely well suited to computing needs in an increasing number of industries.

In the fault-tolerant technology pioneered by Tandem's Non-Stop computer in the mid-1970s, the computer system contains backup systems in case hardware or software should fail. Before fault tolerance, a large computer user's hedge against downtime often involved time-consuming software rewriting, or buying a second computer as a backup.

Tandem built its successful business selling mainly to banks, retailers, transportation companies, and manufacturers. Founded in 1974, the company has grown at breakneck speed to become

the 12th largest U.S. computer maker in 1986, according to the *Fortune 500*. Most industry analysts estimate that Tandem will pass the milestones of \$1 billion in revenue and \$100 million in profits in its 1987 fiscal year, which ended September 30.

The 1980s saw the emergence of Stratus, a startup company that approached fault tolerance in a new way. Whereas



Tandem systems were built around proprietary Tandem hardware and operating-system software, Stratus used commercially available microprocessor chips from Motorola and a version of the Unix operating system developed by AT&T.

Using such industry standards, Stratus carved out a big enough chunk of Tandem's market to achieve revenues of \$125 million in 1986. In the first six months of this year, Stratus earned a profit of \$7.6 million on sales of \$80.2 million.

Although its typical growth rates of 50 percent or better have slowed in recent quarters, Stratus remains a highly profitable operation. But its business has not grown at Tandem's expense; the overall market for fault-tolerant systems will grow 25 percent annually over the next five years, according to

Hambrecht & Quist, a market-research company that tracks the industry.

In 1985, Stratus signed a landmark agreement in which IBM agreed to resell three Stratus units as the IBM System/88 series. In addition to providing revenue, this agreement has helped boost Stratus' technology in the minds of prospective buyers.

"The System/88 was the real coup for the future of fault-tolerant computers," says Jeffrey Canin, who follows Tandem and Stratus for Hambrecht & Quist. "IBM, despite its claims for its own hardware, clearly showed the interest in that technology, and also signaled that there was no proprietary fault-tolerant design imminent from them."

Although Tandem and Stratus have dominated the market for fault-tolerant systems, newer companies are trying to find a niche. The two market leaders sell mostly to end-users, but Tolerant Systems of San Jose, Calif., sells its Unix-based systems only to other manufacturers for resale. Its customers include France's Groupe Bull, Denmark's RC Computers, and the systems-integration unit of Control Data.

Parallel Computers of Santa Cruz, Calif., has chosen a different route. Late last year, Parallel was acquired by General Automation, a company based in Anaheim, Calif., that sells manufacturing minicomputers. General hopes to use its larger size and distribution network to sell Parallel's systems.

"Most commercial systems will soon be doing on-line transaction processing," says Omri Serlin, a consultant and editor of a newsletter on fault-tolerant computing. "That trend will continue for the foreseeable future."

Clinton Wilder is a senior editor and columnist for the computer-industry section of Computerworld.

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**Forbes
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New Uses for Digital Tape

**DATA STORAGE MAY UNLOCK
U.S. MARKETS**

■ By Dorian Benkoil

WHEN MORE THAN a dozen huge Japanese companies introduced digital audio-tape players and recorders at last year's Japan Electronics Show, optimists predicted a \$7-billion market for the new format by 1990. But the realities of high prices, limited software, and trade wars have so far served to keep the tiny cassettes from living up to their advance notices, even in Japan.

In response, the companies behind digital audio-tape technology are considering shifting gears to get their products back on track. In addition to pushing the technology as a means of recording music, several Japanese companies, occasionally in concert with U.S. concerns, are looking into adapting digital audio tape for data storage, mainly to back up hard disks for personal computers.

The need to give the format a jolt is clear. With current prices at \$1,200 a machine and only a few prerecorded tapes in the stores, even Tokyo's Akihabara, the Mecca for consumer-electronics devotees, has more lookers than buyers. In the potentially larger U.S. market, things are even worse. Only Marantz has announced plans to put a digital audio-tape deck in U.S. stores this year.

"For a product that has so much potential, it's disappointing," says Akiko Emori, an analyst with Jardine Fleming (Securities) Ltd. in Tokyo.

Most Japanese companies are postponing any major U.S. marketing of digital audio tape because of a challenge from the U.S. recording industry. The industry fears digital audio tape's chief benefit—the ability to make virtually perfect digital copies of compact disks—will aggravate the \$1.5-million problem of illegal record dubbing. In-

tense lobbying for import restrictions, duty fees, or limits on the tape's copying abilities has kept most Japanese manufacturers out of the U.S. market.

However, if the Japanese adapt the product for data storage, they might be able to make an end run around the recording industry. Several Japanese electronics companies have already be-

mat, R DAT, uses a spinning head much as a video recorder does, Sony and JVC may have an edge because of their strong experience in that field. Matsushita and Toshiba are also considered likely to join the fray soon.

These companies plan to take advantage of the tape's enormous storage capacity by selling it mainly as a backup for computers. R DAT cassettes could potentially hold at least 1.2 gigabytes of information—twice as much as CD ROMs, four times as much as typical optical drives, and ten times as much as popular high-end hard disks for personal computers. At \$15 or less per cassette, the tape's storage price per byte is also dramatically less than any alternatives.

On the down side, the tape's access rate is very slow and complaints about inaccuracy have been raised. Advocates argue, however, that speed won't be a problem because digital audio tape will be used for backup rather than for primary memory. New error-correcting algorithms should help solve the accuracy problem, and companies are working on thicker tape, better magnetic coatings, and stronger bonding processes.

Some experts predict digital audio tape could overtake other forms of data backup. For example, QL Tech's Burr says "data DAT" could set back optical-storage development by three years.

Despite its promise for data storage, so far, Japan's digital audio-tape equipment makers have focused on what they believe will be the far larger consumer market. But as Sony spokesman David Kawakami says, "Consumers are often more inventive than we are at figuring out new applications."



gun to make moves in that direction.

At June's Comdex computer-trade show, Hitachi surprised observers with a tape-deck prototype that stores as much as two megabytes of data on a digital audio-tape cassette about half the size of today's standard audio cassettes. The company hopes to deliver the technology to companies that will sell it to consumers by next summer.

Other Japanese companies are not far behind. In August, Sony announced a joint venture with Hewlett-Packard to develop data-storage uses for digital audio tape. JVC experimented with data applications two years ago; Rob Burr, president of QL Tech, a market-research company that specializes in high-density data, predicts the company will certainly try to keep up with its competition. Burr adds that, because the most popular digital audio-tape for-

Dorian Benkoil works in the New York bureau of Newsweek-Japan and often writes on technology-business issues.



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'Look and Feel' Lawsuits

DECISIONS AGAINST LOOK-ALIKES HURT CLONE PROGRAMS

■ By Richard M. Lucash

A RECENT FLURRY OF lawsuits against the manufacturers of "clones" of popular business programs for personal computers may mean higher costs, more training, and fewer new programs for software buyers.

A clone company typically replicates the operation of a better-known program and sells its program for much less than the original. Until recently, programmers considered clone creation legal. Most programs for personal computers were copyrighted, but copyright was assumed to prohibit only the copying of the code written by programmers. The clone makers thought they were safe because they started with the appearance of the program on the screen and worked backwards, writing their code to produce a program that, without copying the original exactly, had its look and feel.

This process keeps development costs down, and buyers often seek out less expensive programs rather than the ones they replicate. Understandably, the makers of the original programs have been distressed to find competing programs being sold for much lower prices. And now they are fighting back.

First, in 1986, a federal court in the case of *Whelan v. Jaslow* held that copyright law protects not only the exact code written by the programmer, but also its more nebulous overall structure and organization.

This case was followed by one involving a program for home computers that allowed the user to produce greeting cards. The only things replicated were the program's screen displays. Noting that any observer would be struck by the resemblance between the two, the court ruled that the clone violated the

first program's copyright by appropriating its "total concept and feel."

In the wake of these cases, companies such as Lotus, which had suffered for years as copycat programs invaded its market, wasted no time getting to the courthouse. Lotus, whose 1-2-3 program became the first major software package for business, filed suit against the makers of VP-Planner and The Twin,

different. One of the reasons clone companies have been able to sell for less is that programmers don't have to reinvent the wheel; additional time spent developing a product could push clone makers toward higher prices.

That's only one of the arguments clone makers are presenting in friend-of-the-court briefs. Another argument asserts that such costs could keep smaller companies from putting new products on the market; in some cases, uncertainty over the whole situation has already done so. Also, copyrights covering a program's look and feel could make new products less attractive to people who already have wrestled with learning the originals.

Still another line of reasoning says that the need to make new programs look different from earlier ones will reduce the incentive for software companies to try to standardize functions so programs will be easier to learn.

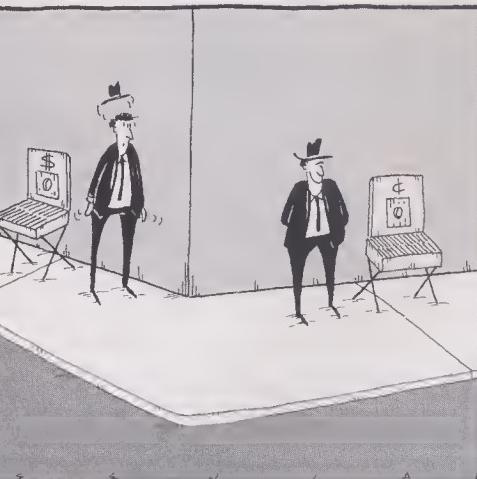
The question of whether the "look and feel" of a program can be protected by copyright is anything but settled. Another federal appeals court has indicated that it may not follow the reasoning of the *Whelan* decision. Also, Lotus has been caught in a Catch-22 by the U.S. Copyright Office. The Crosstalk decision ruled that what a computer program puts on the screen must be copyrighted separately from its code. The Copyright Office contends that a copyright covers both screen display and code, and has refused to register the copyright for 1-2-3's screen displays.

Until such questions are resolved, the controversy has the look and feel of a lengthy battle. ■

which imitated many of 1-2-3's features.

Although the Lotus case filed in January has generated the most publicity, perhaps more significant was the victory won by Digital Communications, a major software producer that publishes the Crosstalk communications package. Unlike 1-2-3, which uses many screen displays, Crosstalk has a single "status" screen. The court ruled that SoftKlone had infringed on Digital Communications' copyright for that screen; indeed, SoftKlone had marketed its product as a Crosstalk clone.

If major manufacturers are successful in protecting the look and feel of their programs, businesses that use computers could feel the impact. Software companies that want to adapt other companies' products will have to make the screen displays and instructions of their programs significantly



MARK KSENIAK

Richard M. Lucash is a partner in the Boston law firm of Lucash & Gesmer, which concentrates on representing software companies.

U.S. Robot Makers Try to Bounce Back

The factory of the future has made a false start, and companies are adjusting

By Herb Brody

AFEW YEARS AGO, robots seemed a sure-fire way to make money. American manufacturers were loudly proclaiming their intentions to build sleek, futuristic factories with productivity rivaling that of the Japanese, and robots were to be the stars of the show. Analysts predicted a billion-dollar market by the end of the decade. Venture capital poured into a flock of startup companies angling to exploit industry's alleged craving for advanced machines.

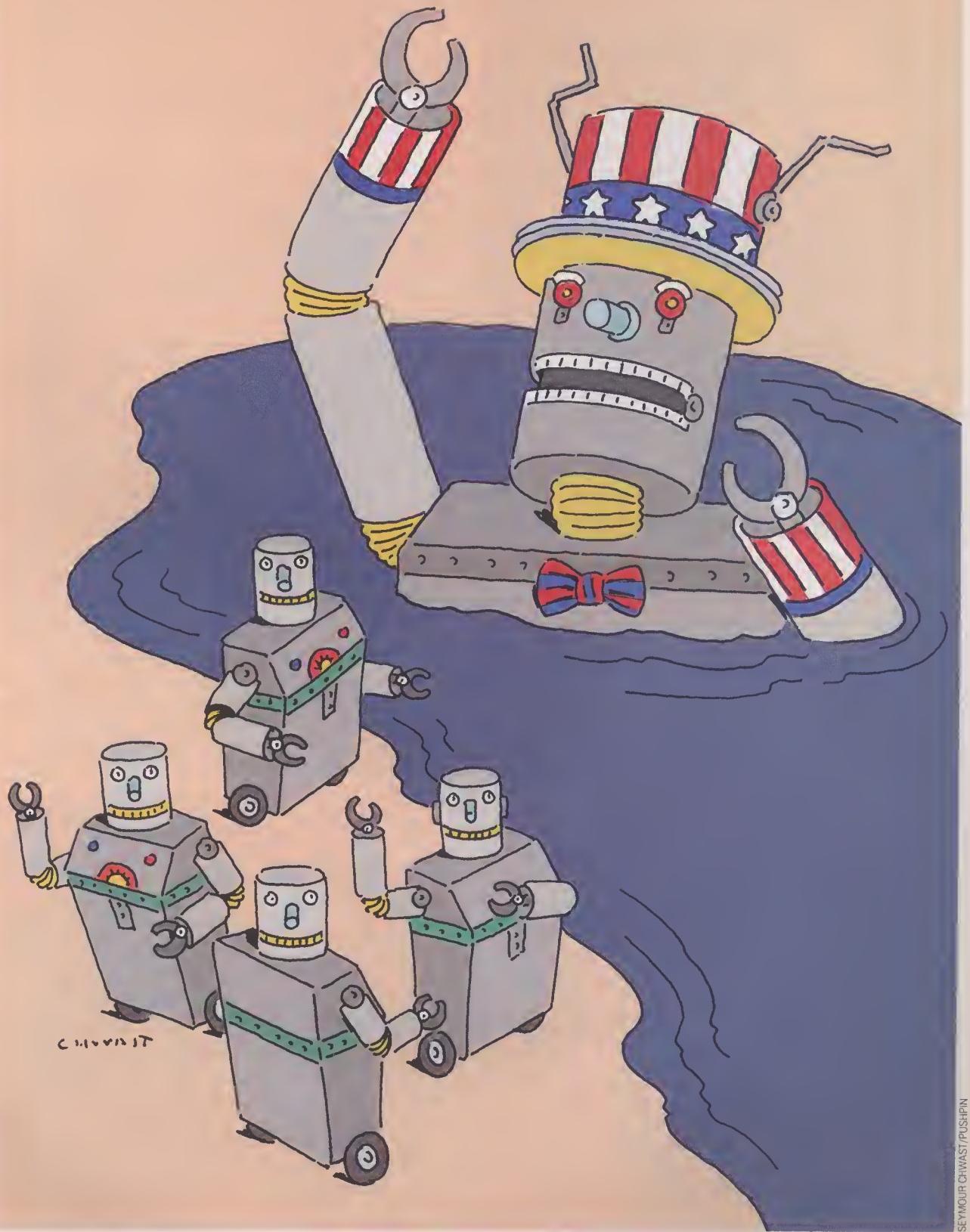
Now, with the venture capitalists' gleeful chortles still echoing off factory walls, it's bust time in robotville. A spending slowdown in the auto industry has contributed to a slump in robot sales this year of 20 to 30 percent from last year's level, estimates Laura Conigliaro, vice president of Prudential-Bache Securities and a leading robot-industry analyst. What's left is a market of about half a billion dollars, which, it is becoming increasingly clear, cannot sustain the many companies that have crowded into the field in the past 10 years.

Partly in response to this decline, some of the big companies that jumped into robotics when times were good have recently abandoned or

sharply curtailed their robot-making operations. Other companies that have staked out the factory-automation market are sharpening their focus, concentrating on a few hot applications such as the assembly of electronic circuit boards and small mechanical products.

Although disturbing to its victims, the ongoing shakeout is not unusual. Once again, the sizzle of a hot new high-tech industry has attracted more players than the market ultimately can support. "Exactly the same thing has happened in industry after industry, including automobiles, semiconductors, and computers," says Eric Mittelstadt, chairman of GMF Robotics in Troy, Mich. GMF, a joint venture of General Motors and Japan's Fanuc, remains the world's largest supplier of robots despite laying off almost one-third of its work force over the past year. GMF's sales will plummet to about \$100 million this year, down from \$186 million in 1986, according to Prudential-Bache.

"It's like a forest fire," says analyst David Penning of Dataquest, a research company. "The dead wood is being cleared away, leaving only the strong trees." That metaphor classifies as "dead wood" two of the world's largest manufacturers





KEVIN HORAN

GMF's Eric Mittelstadt seeks recovery by selling outside the car industry.

of electrical machinery: General Electric and Westinghouse. GE shut down its robot-making department in Orlando early this year and will instead market Japanese-made robots through a joint venture with Fanuc called GEF Automation, in Charlottesville, Va. Westinghouse has consolidated its robotics subsidiary, Unimation, into the company's factory-

automation division—in the process laying off all but 50 of Unimation's more than 200 employees.

One reason for the slump is the growing sophistication of manufacturers regarding factory automation. Contrary to the early hype, it rarely makes business sense simply to replace a human worker with a robot and expect the machine to pay for itself in saved labor costs. The benefits of automation have proven to be more subtle. It's difficult, for example, to quantify financially the advantage of consistent quality, or of a shorter turnaround time between a product's design and its commercial availability.

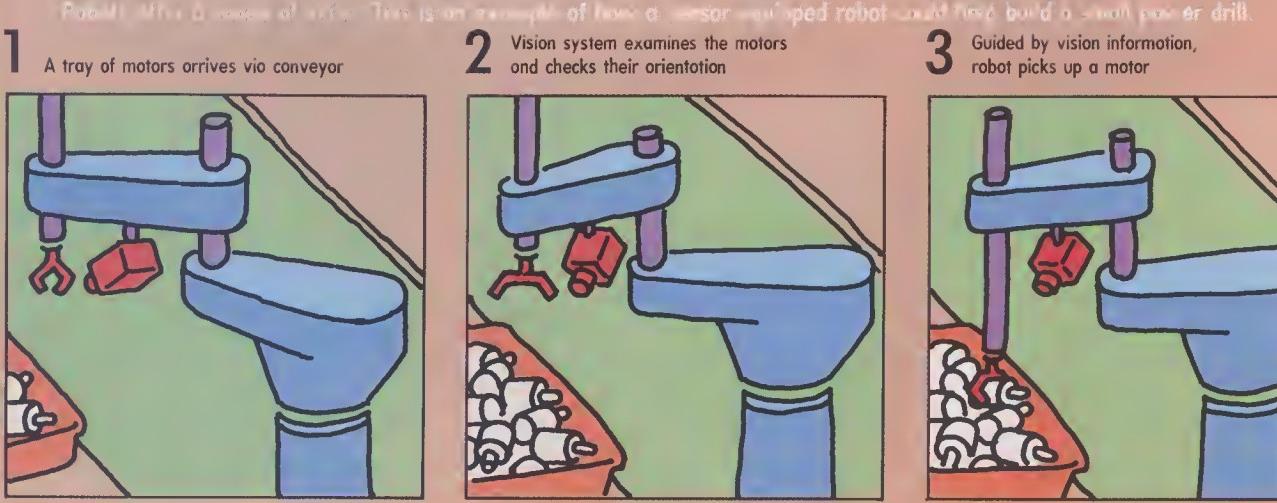
The main benefit of a robot—and the characteristic that distinguishes it from conventional automation equipment—is its flexibility. In other words, a robot can be programmed to move in various ways depending on the job it is doing and the product it is making. This allows quick changes in a robot-equipped manufacturing plant and thus could dramatically lower the retooling costs associated with the introduction of a new product. Short lead time can be crucial in certain fast-paced industries, such as consumer electronics, but this benefit is sometimes not obvious to bottom-line-oriented executives in more conservative businesses.

The earlier idea of a robot as a worker that didn't need coffee breaks got the industry off on the wrong foot. Many predicted robots would become a high-volume, commodity product, each one pretty much like another. Such a market appealed to large companies, which can afford to produce robots in sufficient quantities to make a profit.

As the reality of factory automation supersedes the dream, it's becoming clear that robots do not get plugged into existing manufacturing plants by themselves. Instead, robots are simply one component—albeit a sophisticated one—of an automated factory. Often, the robot simply serves up workpieces to computer-controlled machine tools.

But probably the biggest factor in the decline of the robot business has been the capital-spending cutback at General Motors. GM now has 6,000 robots either in use or on order; supplying the giant automaker has kept the robot business alive. Originally, GM's corporate agenda called for more than

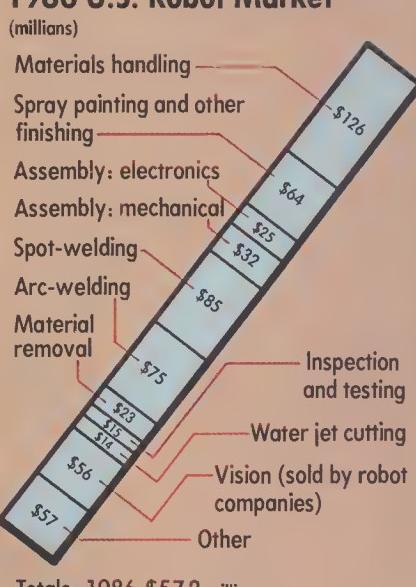
ROBOTS' VARIED ABILITIES



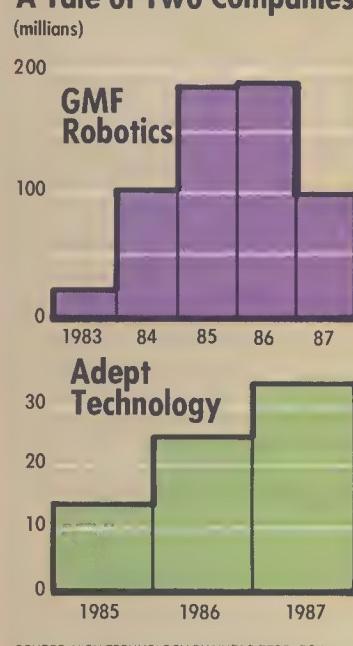
THE ROBOT INDUSTRY AT A GLANCE



1986 U.S. Robot Market



A Tale of Two Companies



CHARTS BY CHRISTOPH BLUMRICH/PUSHPIN

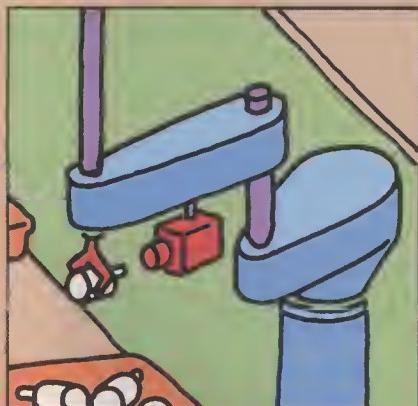
tripling that number by the end of the decade. Robot companies staffed up and built facilities to win massive contracts from GM.

Now the bubble has burst. GM has cancelled ambitious projects that would have required significant additions to its robotic fleet. Sobered by the sometimes inept performance of fancy new factory equipment, the automaker is taking time to "digest what automation we have before moving forward," says spokesman Mark Coccoft. GMF Robotics saw \$90 million in "firm orders" evaporate last year because of shift-

ing plans at its parent organization, according to chairman Mittelstadt, but he resists the suggestion that GMF guessed wrong about the robot market. "It was not that we made wrong assumptions," he insists. "GM was telling us outright that they were going to buy lots of robots, and they were urging the vendors to get on board."

GMF is scrambling to make up for the drop-off by selling robots outside the auto industry, pursuing electronics manufacturers, food-processing companies, and plastics makers, among others. "There are 60,000 to 70,000 companies in this

4 Vision system checks metal for flaws



5 Drill housing arrives via a separate conveyor



6 With vision guidance, robot installs motor; force sensors indicate proper mounting



ONE COMPANY BUCKS THE TREND

Although the robot business overall is faltering, one market segment is showing healthy growth. Manufacturers will spend more than \$100 million this year on robots that can pick up, move around, and put together small parts. Such robots put electronic components on printed-circuit boards, for example, and assemble a variety of mechanical products, from hand drills to vacuum cleaners. By 1990, half the robots sold in the United States are expected to be used for such light (less than 15 pounds) assembly operations.

As a result, many of the major robot manufacturers are aiming for a share of the small-parts assembly market. To do so, they are turning to such advanced technologies as sensors, which give a robot the ability to see or feel what it's doing.

Some companies have been able to find success in this part of the industry by reacting quickly to advances in technology. For example, Adept Technology is widely acknowledged as the leader in robots for small-parts materials handling and assembly, despite intense competition from the likes of Japan's Seiko Instruments and world robot leader GMF Robotics. The company introduced its first products in 1985 and within a year was outselling then-market-leader IBM.

Adept's edge is partly technological. For example, it remains the only company to offer "direct-drive" robots, in which the motors transmit motion to the robot's joints without gears. Such robots remain very precise longer than conventional machines because there are no gear teeth to wear down. This is crucial in small-parts assembly, where even tiny errors can ruin the product.

Also, Adept has focused heavily on sensor-equipped robots; more than a third of the robots it ships, according to chairman and CEO Brian Carlisle, sport artificial vision. Such vision systems—basically a video camera hooked to a computer that analyzes the image—perform several func-

tions. They can help the robot identify which screw to pick up, guide the robot hand to the correct hole, and inspect the finished product for flaws.

Also important for Adept has been the software that tells the robot what to do. Bruce Shimano, one of Adept's founders and now vice president of research and development, invented one of the first computer languages (called VAL) tailored specifically for industrial robots. In addition, Adept recently



Adept's Brian Carlisle co-founded the leader in the assembly-robot market.

introduced software called AIM, in which a single command sets off a sequence of operations needed for an intricate series of complex manufacturing tasks. AIM is designed to streamline robot programming for assembly tasks much the way 1-2-3 and other spreadsheets simplify financial planning, says Carlisle.

But advanced technology alone cannot guarantee success in the light-assembly market. Indeed, fundamental to Adept's strong performance has been the company's marketing strategy. Since its birth, Adept has pitched its products to a variety of industries. By contrast, many other robot makers have relied heavily on automobile manufacturers. Thus Adept, unlike competitors such as GMF, has not felt the sting of General Motors' automation purchasing cutbacks.

In another crucial tactic, Adept has resisted the trend toward selling robot systems that include all the computers, software, and equipment needed

on the factory floor. Instead, Adept sells only robots—some directly to end users, but many to systems integrators that consolidate equipment to meet a manufacturer's needs.

According to Philip Monnin, the company's vice president of marketing, Adept's 22-person sales force concentrates on arranging "marriages" between potential customers and systems integrators. By staying out of the systems business, Adept has avoided competing against its main customers. This marketing approach has not been copied successfully by other robot sellers, according to Laura Conigliaro, a vice president of Prudential-Bache Securities and a long-time analyst of factory automation.

Adept founders Carlisle and Shimano have been taking aim at the assembly-robot market for more than a decade. They originally worked together at a small company called Vicarm, which in 1976 built the first computer-controlled electric robot. (Previous robots used

cumbersome hydraulic mechanisms and had to be physically "taught" their moves.) In 1977, Vicarm was bought by Unimation of Danbury, Conn., and became that company's new-product-development unit. This group was reborn as Adept Technology after Westinghouse bought Unimation in 1983.

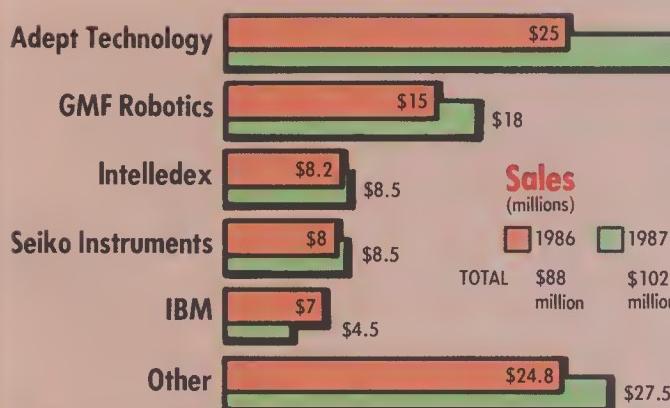
Adept's ability to take advantage of the market's new direction has proved profitable; sales spurted from \$14 million in 1985 to \$25 million last year, and 1987 revenues are projected at \$34 million. In June, Adept finished its sixth consecutive money-making quarter. The staff has grown to number 200 people, with offices in Cincinnati and West Germany; the company also has a new 90,000-square-foot facility in San Jose, Calif.

"The people who started this company did so partly so as not to have to work for a large corporation," says Adept vice-president Monnin. "I tell them to watch out, because that's what we're becoming."

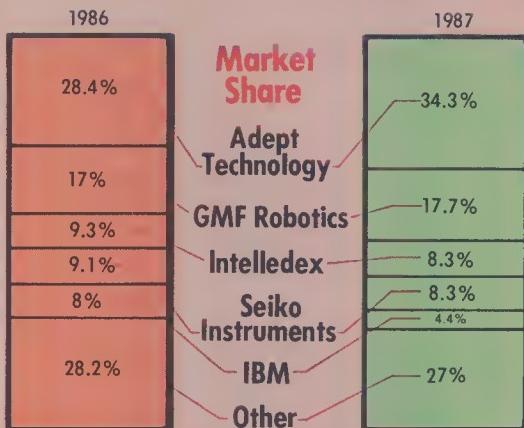
ROGER RESSMEYER

THE HOTTEST ROBOT MARKET

Small-Parts Handling and Assembly



SOURCE PRUDENTIAL-BACHE



country, and less than five percent of them have even one robot," Mittelstadt asserts. For GMF to succeed, he says, "we need to have lots of eggs in lots of baskets."

That's a tall order, he concedes. "We're trying to replace a customer who ordered robots by the hundreds—GM—with new customers who buy four or five at a time. It will be painful for a while, but the potential is there. There's no question that this could become a \$2-billion or even a \$5-billion market. The key will be the ability to sell to thousands of customers."

But even though GMF has been harder hit than most robotics companies by GM's automation slow-down, it is not on the verge of collapse. "They've got a long way to fall before they hit zero," says analyst Conigliaro. During the first half of this year, 60 percent of GMF's orders came from outside the car industry. Mittelstadt notes that in the same period of 1986, that figure was 15 percent.

While robot makers wring their hands over GM's drop-off in orders, they turn a hopeful gaze to another of Detroit's Big Three. Chrysler Motors is "the robot industry's great white hope," says Walter Weisel, president of Prab Robots in Kalamazoo, Mich. The car company encourages that notion. "We will add 1,000 robots in the next five years—half a billion dollars worth," declares Richard Dauch, Chrysler's executive vice-president for manufacturing. That figure does not include purchases by Chrysler's recently acquired subsidiary, American Motors.

But the robotics casualties cannot lay all their woes at GM's door. Consider the fate of Unimation, which was among the first companies to make a go of commercializing industrial robots. In 1983, after Westinghouse bought the pioneering company for \$107 million, all the key research-and-development staff left. In what industry analysts call a major strategic blunder, Westinghouse offered "no incentives to keep the key technical people," recalls Unimation's founder, Joseph Engleberger, who left Unimation after it was bought to become president of another robot company.

This proved all the more destructive because, at the time, the company was making a type of robot that was rapidly becoming obsolete. Manufacturers passed over Unimation's hy-

draulic robots in favor of more-versatile electric robots, which were more accurate and avoided the hydraulic robots' occasional tendency to leak fluid all over the product being manufactured. Competitors such as Cincinnati Milacron of Lebanon, Ohio, which were forced by their customers to make electric robots earlier in the game, are well positioned to exploit what's left of the robotics market, market analysts say. Cincinnati Milacron's robot division lost money in 1986, says Penning of Dataquest, but it should break even this year.

Unimation's departure spells relief for another robot company. Prab Robots has suffered four straight years of losses. But this spring, Prab struck what promises to be a profitable deal with Westinghouse. For an undisclosed price, Prab bought a license giving it exclusive rights to manufacture, "remanufacture," and service the 3,600 Unimation hydraulic robots now in the field, as well as to replace them with comparable Prab models. "We succeeded in catching the falling knife," as president Weisel puts it.

The demise of Unimation does not surprise Weisel. "Unimation was far too small to be of much interest to an \$11-billion company like Westinghouse," he says. But Prab, with revenues of about \$20 million, sees Unimation as "exactly our cup of tea." Weisel expects Prab to show a profit this year for the first time since 1982. That turn in fortune reflects not only new business from the assumed Unimation customers, but also severe cuts in operating costs. In the last 10 months, says Weisel, Prab has dismissed about 15 percent of its work force.

General Electric, like Westinghouse, started selling robots back when analysts were persistently forecasting huge markets. GE focused on welding systems that used computer-aided vision to guide the torch. The company imported Japanese robots and supplied the vision apparatus and the electronic controls. However, the market never took off the way GE had hoped. GE has now abandoned the manufacture of robots; instead, the company has struck a deal with Fanuc (the same Japanese company that co-owns GMF Robotics with General Motors). Thus, GE acts essentially as a U.S. sales agent for its former competitor.

Other Japanese companies may be starting to emulate

JAPAN MOVES IN

In Japan, most big manufacturers (and even some not-so-big ones) make some of their own factory-automation equipment. A number of these companies have decided to increase their revenues by selling robots not just to their own plants, but to the outside market as well. Some of these Japanese suppliers provide tough competition for U.S. robot makers, who are fighting to retain their shares of a stagnant market as it is.

The extent of the Japanese share of the U.S. robot market is hard to estimate, because many companies are involved with U.S. robot makers. For example, the Japanese company most embedded in the U.S. robot scene is Fanuc. Although it sells some robots directly to U.S. manufacturers, Fanuc's main activity revolves around a joint venture with General Motors called GMF Robotics. GMF, formed in 1981, sells more robots than any company in the world. The robot arms and motors are made by Fanuc, many of them in a super-automated factory that operates around the clock, with robots outnumbering human workers

five to one. The U.S. side of the operation concentrates on the robots' computers and software.

Early this year, Fanuc formed an alliance with another huge U.S. corporation: General Electric. This venture, called GEF Automation, is targeting the more general market of factory-automation systems rather than concentrating on robots. Another U.S.-Japan robotics partnership involves Westinghouse. A few months after essentially closing down Unimation, its U.S.-based robot-making subsidiary, Westinghouse announced plans to team up with Matsushita, the world's number-three robot maker (GMF ranks first, Sweden-based ASEA second). It's not clear whether Westinghouse and Matsushita will form a joint venture such as GMF or enter into a more limited marketing agreement akin to the one underlying GEF.

Other Japanese companies have sold robots in the United States for years, but you'd never know it by the labels that appear on them. IBM's assembly robots, for example, have been made by Sankyo Seiki. Kawasaki—

one of the world's top 10 robot suppliers—manufactured many of the robots shipped under the Unimation name. General Electric, before abandoning the robot business altogether, sold robots from Hitachi and from Nachi-Fujikoshi. GCA and CIMCorp get their robots from Dainichi-Kiko.

Several Japanese robot-makers are hotly pursuing the assembly-robot market. Leading the pack is Seiko Instruments, an arm of the giant Seiko Group. In the past year, competition has come from a sister company, Seiko/Epson. Driven by the demands of its watch-making operation, Seiko/Epson developed a family of fast and nimble robots that are marketed in the United States through Kanematsu-Gosho, a trading company. At one of the company's plants in Japan, a 48-robot assembly line spits out a watch a minute in a variety of styles.

But the Japanese companies are coming out from behind the skirts of their American partners. With GE out of the business, both Hitachi and Nachi-Fujikoshi have taken to marketing their products directly.

Fanuc. Matsushita—the conglomerate that markets consumer and industrial goods under such familiar trade names as Panasonic—is forming an alliance of an unspecified nature with Westinghouse. The deal was announced weeks after the Unimation consolidation, and indicates that Westinghouse, like GE, figures it will be more profitable to import and resell than to manufacture.

Some bright spots shine through the overall gloom of the robotics scene. The market for assembly robots is the most rapidly growing segment of the robot industry, and should total about \$100 million this year, according to Brian Carlisle, chairman of Adept Technology of Sunnyvale, Calif., a leading assembly-robot maker. Some 30 percent of the buyers are electronics manufacturers, which use the nimble machines to insert components onto printed-circuit boards. Other applications include the manufacture of cars (20 percent of the assembly-robot market), aerospace systems (17 percent), industrial equipment (17 percent), and appliances (10 percent).

Robot makers recognize the value of the assembly market. Adept's competition includes GMF Robotics (which sold about \$15 million of assembly robots last year); Intelledex, a venture-capital-backed spin-off of Hewlett-Packard based in Corvallis, Ore., (\$6 million); and Seiko (\$11 million). IBM remains a force, selling about \$8 million worth of assembly robots per year. IBM makes only the computers and software that control the robot; the arm itself is imported from Japan's Sankyo Seiki, according to

Bruce Haupt, a manager at IBM's robot-making division in Boca Raton, Fla. About a quarter of these robots are sold to IBM's own manufacturing plants, and the rest are marketed to the industry at large.

Although the industrial-robot business has hit some hard times, fertile market opportunities may lie in nonfactory applications. Transitions Research of Bethel, Conn., the company founded and headed by Unimation's Engleberger, is developing service robots to work in hospitals, restaurants, and other institutions. "There's a multi-billion-dollar market," Engleberger claims.

Transitions' first product—a robotic nurse's aide—will soon enter trial use at Danbury Hospital in Connecticut. The robot will perform such time-consuming but undemanding chores as fetching special meals for patients on a restricted diet, carrying blood samples to the lab, and otherwise freeing nurses to provide more highly skilled services.

But Engleberger wants to bring robots home. Of the houses that begin construction each year in the United States, he says, five percent sell for more than a quarter of a million dollars. He believes that the affluent people who buy such homes will not blink at adding \$50,000 to their mortgage for what he says will be the "single biggest luxury consumer item of the next five years."

The image of a robot butler serving drinks and taking in the mail has little in common with the industrial surroundings of today's factory robots—little, that is, except the disturbingly reminiscent promise of huge profits.

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- Seybold columnist and staff futurist Fritz R.S. Dressler predicted a boom in the workstation market in the January 1986 *Andrew Seybold's Outlook*. Dressler called workstations the "silicon pathways into the twenty-first century ... to complete the second industrial revolution that's now underway."
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Scanner Standards: Who Will Emerge?

Desktop publishing could dramatically transform scanner sales

Remember what happened to computer printers when personal computers began redefining offices? Suddenly, everybody needed one to take advantage of the potent new technology.

The same thing could be about to happen with scanners, the machines that convert a printed page into something that can be processed by a computer. New interest spurred by the potential of desktop publishing has companies jockeying for position to become the leader—or at least one of the leaders—in what some analysts have predicted could become an explosive business in the next five years.

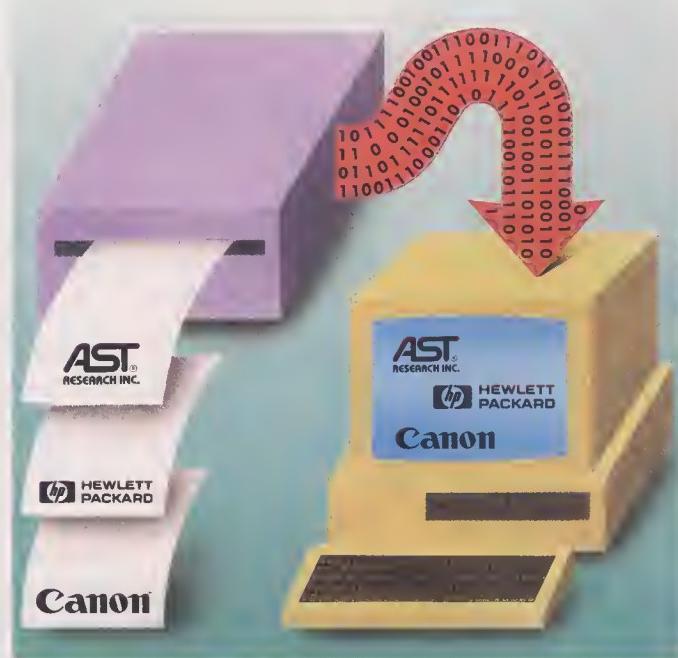
Scanners have been around for years, in a relatively simple form; any-

one familiar with a facsimile-transmission (fax) machine has come in contact with a scanner. But scanners increasingly are being used to capture graphic images as well as words so both can be dealt with via computer; as a result, scanners are becoming increasingly val-

uable to businesses that design products on computers or generate anything that combines words and pictures.

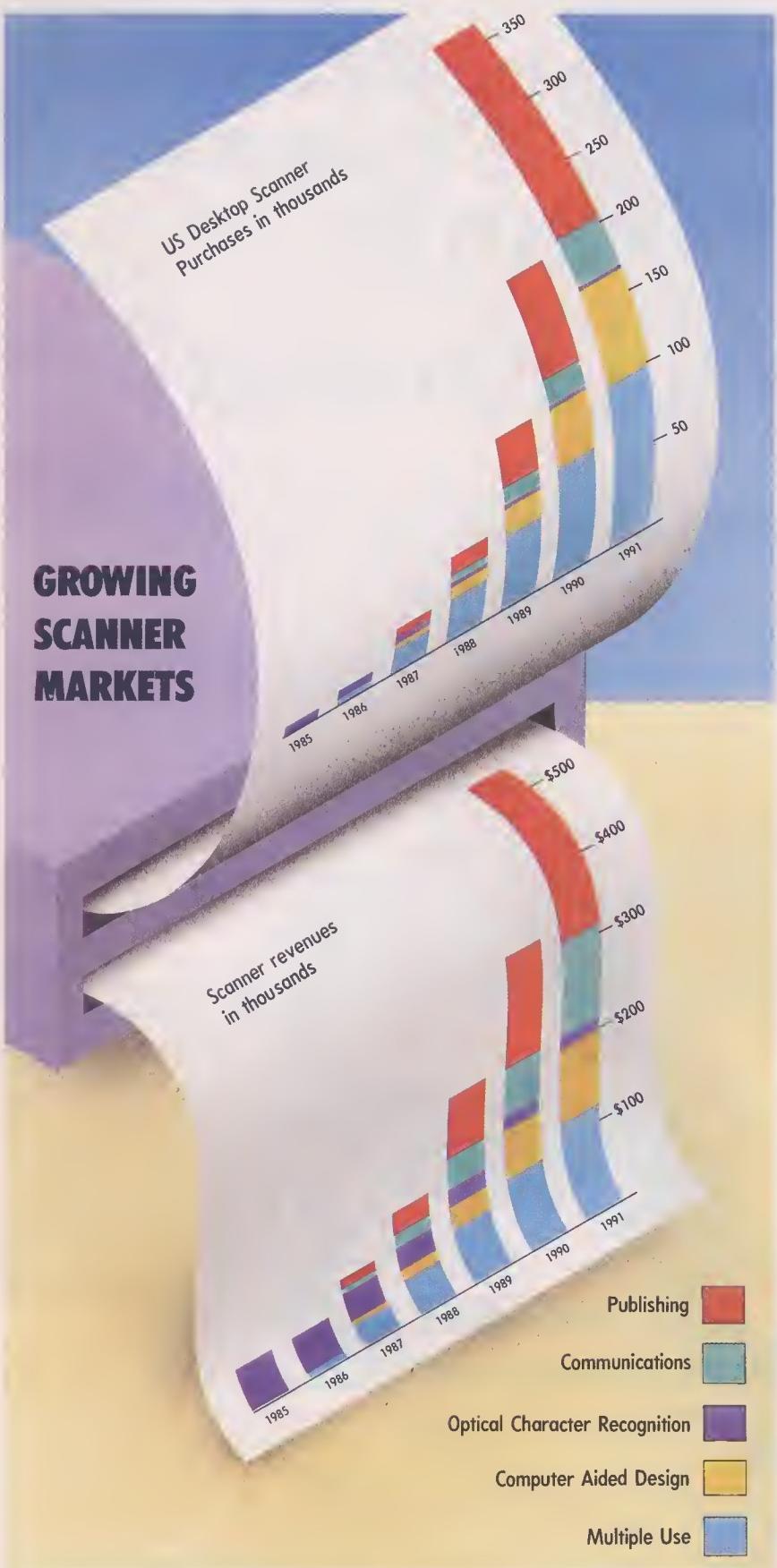
"The market for scanners has been almost nonexistent," says Don Ryan of CAP International, a market-research company that recently compiled a report on scanners. However, he predicts, a variety of factors will change that situation over the next five years.

Until recently, the most important function of scanners has been optical character recognition (OCR), in which the machine simply reads words from a page and translates them into a form computers can use. However, for the last few years sales have been flat, and CAP International projects that OCR will eventually become little more than one



CHARTS BY JOE LERTOLA

GROWING SCANNER MARKETS



of several scanner-software options. Desktop publishing is putting the tools of professional typesetters and printers into the hands of individuals, and some analysts predict it could represent anywhere from 50 to 80 percent of all scanner sales next year, which Ryan estimates will total \$126 million.

The speed at which desktop publishing grows could help determine which companies dominate the scanner competition for the new low-end market. For example, if scanner use becomes ubiquitous in the next year or so, large companies with well-established distribution channels should do well.

Ryan expects the market to be strongly affected by price, which would also tend to favor larger companies. "Most [companies] are going for the low-end market; nobody's going to buy a \$10,000 scanner to hook up to a \$5,000 computer," Ryan says. "The market will be very price driven, and it will be a question of who can bring down manufacturing costs fast enough."

If that's true, volume manufacturers such as Canon and Ricoh would seem to have an advantage. However, they and other large Japanese manufacturers such as Panasonic and Sharp probably will have little success marketing scanners directly, for the same reason they have failed to market laser printers: their difficulty marrying hardware to software. With the exception of Panasonic, which is trying to establish its own retail distribution channel, most contenders are concentrating on sales to American companies, which then couple the scanners with software and market the resulting product.

But where such behemoths fear to tread, Taiwan-based Microtek is stepping in. Of the Pacific Rim scanner makers, it alone has an established retail-product line as well as contracts to supply other companies. Also, Microtek has demonstrated some understanding of the American software market; it made 28 percent of the scanners shipped last year. In the past, Microtek has limited itself to semiconductor test equipment and numerical machine-tool controllers. Scanners will be the first large-volume product for the company, which has sales of only a few million dollars a year compared to Canon U.S.A.'s \$2 billion.

How can such a David survive among the Goliaths, with the added burden of slightly higher prices than those of its Japanese competitors? The company



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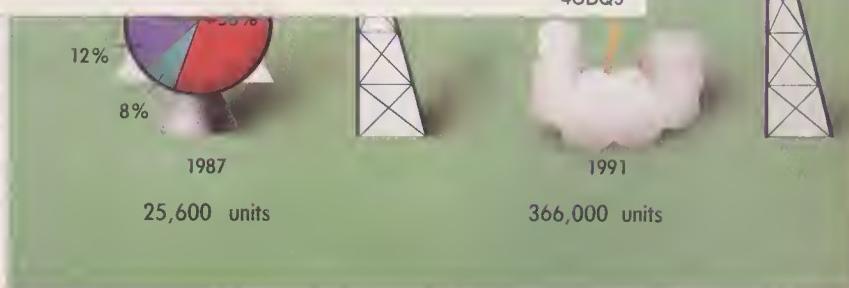
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software companies to write programs that work on a number of different scanners. Datacopy plans to put the language in the public domain, the idea being that widespread use of a universal language will increase the market for scanners generally. If Datacopy can convince other scanner companies to adopt PreScript as an industry standard, it can establish itself as the software technol-



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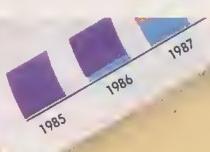
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How can such a David survive among the Goliaths, with the added burden of slightly higher prices than those of its Japanese competitors? The company

offers software as well as hardware to its American marketers, and argues that its small size makes it far more flexible than its opponents. Microtek's chances will improve if the market develops slowly and the company has a chance to strengthen its distribution channels.

American companies have a proven track record in coupling Japanese hardware with the software that suits it for a variety of uses. Hewlett-Packard, the largest American company now offering a scanner, has done well selling laser printers. The company's size and success give it a strong head start in the scanner race, because many customers who bought its printers may come back for a scanner.

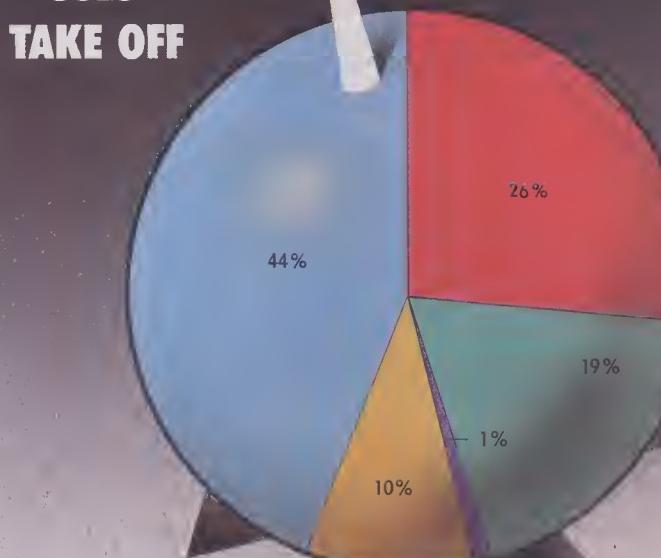
Because the company entered the scanner market only a few months ago, it does not yet have a sales record. But industry analysts expect it to capture a quarter of the market for the second half of 1987 and generate \$10 million in scanner sales.

AST Research of Irvine, Calif., which established its reputation making memory boards for the IBM PC and has since diversified, has added a scanner to complete its desktop-publishing line. The company buys both its hardware and software from Microtek; AST entered the market about nine months ago and its currently strong scanner sales come mainly from established retail distribution channels. In 1987, industry observers think AST could sell \$5 million to \$8 million in scanners.

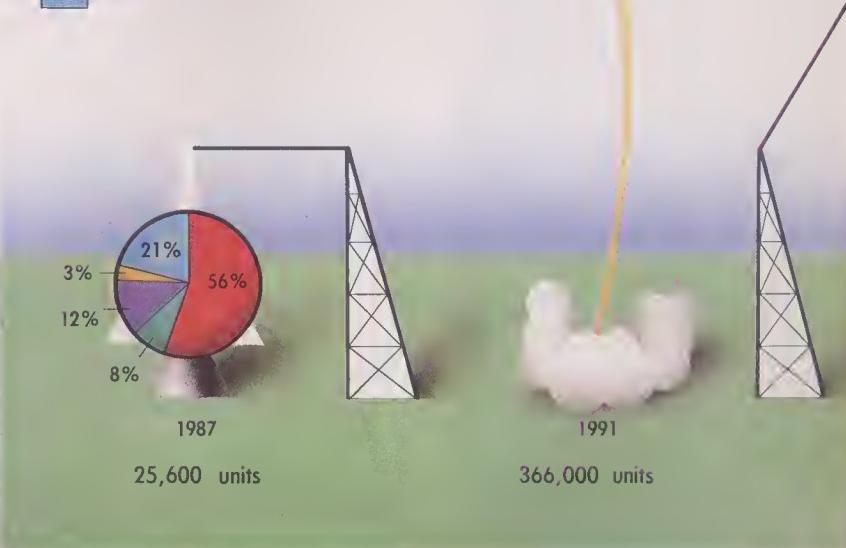
With 1986 sales of \$7.4 million, Datacopy, which sells Ricoh hardware, is the leader among companies that concentrate on scanners. Diversity within that market has become the cornerstone of the Mountain View, Calif., company's strategy; its software supports nearly every scanner use, including fax, optical character recognition, and IBM or Macintosh computers.

Datacopy's most ambitious effort may bear fruit this fall when it releases a computer language called PreScript. This language would make it easier for software companies to write programs that work on a number of different scanners. Datacopy plans to put the language in the public domain, the idea being that widespread use of a universal language will increase the market for scanners generally. If Datacopy can convince other scanner companies to adopt PreScript as an industry standard, it can establish itself as the software technol-

SCANNER USES TAKE OFF



- Publishing
- Communications
- Optical Character Recognition
- Computer Aided Design
- Multiple Use



WHAT SCANNERS CAN DO

A scanner is essentially an inverse printer; instead of putting an image on paper, a scanner reads an image that is on paper already. Even though scanners are rare computer accessories, scanner hardware is already a commodity item. All facsimile (fax) machines contain a scanner, and the most common scanners sold for computers are simply modified fax machines; they may even share the same plastic case design.

The main difference between the two technologies is that a computer scanner typically operates at higher resolution—300 dots per inch instead of a fax machine's 200—to produce crisper images that match the quality available from common laser printers.

Scanner software comes in several forms:

■ **Graphics scanning.** The software converts the scanned image into any of several formats. These formats allow computer programs, such as those for page layout or computer-aided design, to manipulate and print the image. Companies that want to print a graphics image without having to create it themselves use graphics-scanning software to incorporate graphics in text.

■ **Optical character recognition (OCR).** Instead of producing pictures, OCR software works with a computer to analyze patterns on paper to "read" text. In the publishing business, for example, an original manuscript scanned by OCR software can be prepared for electronic typesetting without having to be typed into the computer system.

■ **Fax input.** Working much like a long-distance photocopying machine, fax hardware and software transmit pages that may contain both text and graphics over a telephone line. Fax machines are already common in many offices, but personal computers equipped with a scanner and laser printer to act as a fax machine are relatively new. ■

ogy leader. This strategy is relatively low risk, because the company's investment in PreScript is modest.

Should Apple decide to enter the market, it would seem virtually assured of success. The Macintosh is sold as a graphics computer, and Apple's LaserWriter printer was the first good graphics printer for personal computers; customers expect Apple to produce a good scanner.

IBM is harder to figure. It may be the dominant computer maker, but its record in producing graphics devices has been very poor, and it has already flopped once with scanners. Recently, IBM brought out a scanner made by a Japanese subsidiary that was clumsy and could not match the image clarity of competitive products. The scanner was designed to work with an IBM page printer that has not been successful.

The American market also has a David—Dest, a company in Milpitas, Calif., that has been competing with relatively small companies in the high-end text-scanning market for 15 years and last year introduced its own U.S.-made image-processing line. Although Dest's \$22 million in sales for the last fiscal year can't match those of such companies as Hewlett-Packard, its longevity in the field and established sales network should help it compete with much larger companies for the low-end desktop market.

But not all scanner companies are pursuing desktop publishing. Some smaller companies are trying to avoid competing against the big companies directly by limiting their focus to such functions as text scanning.

For example, Saba of Beaverton, Ore., is going after the low-end text-scanning market for the IBM PC with a Canon-made scanner and its own text-scanning software. The hardware isn't really suited for desktop publishing because the resolution is relatively low. However, the machine puts fewer demands on an IBM PC's memory, which can buckle under the requirements of scanners that give sharper images than Saba's. Saba believes its \$1,300 product will appeal to computer users who deal with words rather than graphics.

At the very low end, Thunderware of Orinda, Calif., and Japan's Epson sell scanners that cost only a couple of hundred dollars. Neither product is particularly accurate, however, which makes them unfit for desktop publishing.

The great challenge for the scanner

industry is to reach a highly fragmented and ill-defined market. Although every computer-equipped office is a potential buyer, scanners are still so novel that few people know they need one or what they would do with it. Retail stores are hardly equipped to demonstrate and sell scanners effectively. Scanner companies are thus forced to create their own market through expensive advertising campaigns that must educate as well as sell a product. The pioneer companies have borne these costs so far, but they run the risk of establishing their products only to see giant latecomers such as Apple and IBM get the sales.

Technical problems also could slow market development. IBM PCs and com-

The speed at which desktop publishing grows could help determine which companies come to dominate the scanner competition for the new low-end market.

patible units account for most of the personal computers in use today, but they are poor vehicles for graphics software. Among other things, as previously noted, they lack the memory to process the high-resolution images generated by scanners and necessary for many desktop-publishing purposes. The Macintosh was designed for graphics, but even most of today's Macs need extra memory to manipulate scanned images well.

The CAP International report predicts that the number of scanners dedicated to one use such as text-scanning will decline; those that can handle a number of different tasks (such as entering images for publishing or fax messages as well as text-scanning) will be most in demand. Flexibility, it seems, is a key word for anyone trying to put a scanner in every office. ■

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Money Machines Outgrow Banking

Fast-cash networks find new business with stores and service industries

BY BARRY ROSENBERG

TO A HANDFUL of computer companies, the automatic teller machines so prevalent now at banks are an idea whose time had come—and gone. Banks installed about 14,000 of the computerized terminals in 1983, the best sales year ever for the machines. But then shipments dropped off. The success of automated tellers has been the downfall of their makers; any bank that wants to buy such systems has already done so.

But changes in electronic fund transfer could bring new life to a flat market. On the way are computerized networks that automatically debit a shopper's bank account when he or she buys something. Computers, called "point-of-sale" terminals, are used at gas pumps, check-out counters—almost any place where consumers consume. Linked to automatic tellers in large networks, these computers can direct money from consumers to bank to store—and back again.

"Improved speed, efficiency, and convenience is what point-of-sale is all about," says Jeffrey Novotny, manager of financial marketing support for Fujitsu Systems of America, the fourth largest supplier of automatic-teller machines in the United States. "It's going to become a fact of American life," he predicts.

About 35,000 point-of-sale terminals have been installed, and many of the companies that make them are already working on advances that will enable people to do their banking, make airline

reservations, and even buy theater tickets in one stop.

But computer hardware makers aren't the only ones that will benefit from increased automation of retail sales. Automatic-teller networks such as Cirrus and Pulse, which operate the electronic switching and communication services that link the machines, are scrambling to augment their banking business with point-of-sale terminals. The debut of national point-of-sale systems next year that will accept MasterCard and Visa credit cards is expected

to kick off a battle for dominance of such systems.

Point-of-sale terminals use the same technology as automatic-teller machines. When a customer inserts a card, a magnetic strip on its surface activates the machine; after the customer enters a personal identification number, the computer matches it to the account information encoded on the strip. The customer can then transfer money among accounts and deposit or withdraw cash. Point-of-sale transactions work the same way, except that the card enables the machine to electronically debit a cardholder's account for purchases and credit the amount to the retailer's bank account. No cash or credit-card slips are involved in the transaction.

Fifty-eight percent of the 35,000 point-of-sale terminals now in use are in gas stations (where customers are already accustomed to self-service, and which represents the biggest potential market) and specialty stores. Frost & Sullivan, a market-research company, estimates that another 15 percent are in department stores, and 13 percent in supermarkets. A Frost & Sullivan study of the market predicts that, by 1991, 400,000 such terminals may be plugged in across the United States, and installations could more than double each year.

However, many observers of the electronic-fund-transfer business are skeptical of growth projections. "We see it as a growth area, but the speed with which it will be embraced is difficult to project," says Novotny.

LEADING U.S. SUPPLIERS

COMPANY	MARKET SHARE	1995 FORECAST
Diebold Box 8230 Canton, OH 44711 (216) 497-5018	41%	44%
NCR 1700 S. Potterson Blvd. Dayton, OH 45479 (513) 445-4051	24%	24%
IBM Old Orchard Rd. Armonk, NY 10504 (914) 765-1910	15%	20%
Fujitsu 12670 High Bluff Dr. San Diego, CA 92130 (619) 481-4004	11%	2%
Omron 720 N. Post Oak Rd., Suite 230 Houston, TX 77024 (713) 957-1606	4%	4%

SOURCE: BANK NETWORK NEWS/NILSON REPORT



"Diebold is carrying self-service technology into new markets," says vice president James E. Leierzapf.

One big problem is customer acceptance. Some shop owners get nervous when cash and credit-card slips stop flowing into the register, replaced by less-tangible electronic blips. Also, networks and retailers are haggling over prices. Shop owners think they should be paid for allowing a network's machines into their stores; some network operators, on the other hand, expect the opposite.

Because point-of-sale machines do not require the hefty security and elaborate machinery of teller machines to deal with cash, they are relatively inexpensive (\$1,500 to \$5,000 compared to \$27,000 for an automated teller). As a result, many of the makers are small companies that are attracted by the lower investment cost. According to the industry journal *POS News*, leading contenders include Omron of Irving, Tex.; Datatrol of Hudson, Mass.; Taltek terminals from Dallas' National Business Systems; and VeriFone of Redwood City, Calif. DMC, a company in

Santa Clara, Calif., has signed an agreement making AT&T the distributor of its terminals. Icot of San Jose, Calif., recently sold 10,000 terminals to MasterCard for use in a point-of-sale network, and another 5,000 terminals to K Mart.

The predictions that have point-of-sale manufacturers smiling do not carry over to the companies that lead the market in automated-teller sales, despite the similar technology. Docutel, the Italian-owned company that introduced teller machines to America, abandoned the highly competitive market last year. That leaves five major manufacturers—Diebold, NCR, IBM, and Japan-based Fujitsu and Omron—to pick up the replacement of Docutel's approximately 8,000 machines, which are now five to seven years old. Company spokesmen predict the replacement market will account for about 45 percent of sales by 1990.

"The bloom is off for manufacturers," says Alden Briggs, a senior consultant at Arthur D. Little. "Automatic

teller machines have become a mature product."

However, the large companies are by no means ceding the point-of-sale market to smaller contenders. NCR has an easy entree into the market through its large electronic-cash-register business. Point-of-sale represents a natural extension for the other automatic-teller makers as well.

As they move into point-of-sale, these larger companies are also developing the next generation of electronic-fund-transfer machines, which will offer shoppers multiple services. People will be able to do their banking, obtain tickets, or conduct nearly any other transaction that exchanges money for a printed form. However, few estimates exist on when such services might become available.

In addition, automated-teller makers have other projects in the works. For instance, Diebold offers terminals for dispensing video-cassette rental movies, and for selling ski-lift tickets. American Express uses electronic fund transfer to sell traveler's checks in airports, Avis handles some rental-car return with the machines, American Airlines recently bought 5,000 terminals to dispense tickets in travel agencies, and a pilot program in the Midwest automatically credits welfare checks to recipients through a teller network.

Whenever point-of-sale arrives—and everyone agrees that it will—it will be great news for the automatic-teller-network operators that are scrambling to be ready to link the machines. These networks, formed during the last decade, are usually owned by a consortium of the banks served, and may be regional or national.

If a cardholder's bank belongs to one of the 130 automated-teller networks, he or she can get cash from any machine in the network. The transaction flows from the machine (via the bank that operates it) to the network, also called a switching company. Network computers automatically route the request to the customer's home bank, where other computers authorize the transaction and debit the account. The information then flows back to the network or switching company, which gives credit to the bank that dispenses cash to the customer.

Only one network—San Francisco-based Interlink, serving California, Arizona and Nevada—has sprung up to handle point-of-sale exclusively. It oper-

THE TOP 10 REGIONAL NETWORKS

Network name	Operated by	Region	Number of cards	Average 1986 monthly transactions	1986 transactions growth
MAC	Maney Access Service 80x 7618 Philadelphia, PA 19101 (215) 629-4843	Pennsylvania, New Jersey, Delaware	5.6 million	9.3 million	46%
MPICT	MTech 80x 152055 Irving, TX 75015 (214) 742-7100	Texas, Oklahoma, Louisiana, Arkansas, New Mexico, West Virginia, Massachusetts	2.4 million	7.8 million	21%
XPress 24	BayBanks Systems 1025 Main St. Waltham, MA 02154 (617) 642-1050	Massachusetts, New Hampshire	1.3 million	6.5 million	17%
CashStream	Mellon Bank Network Services 1 Mellon Center Pittsburgh, PA 15258 (412) 234-2635	Pennsylvania, New Jersey, Delaware, Maryland, West Virginia	4.5 million	5.4 million	12%
Exchange/Accel	Northwest Switching System 15395 S.E. 30th Place Bellevue, WA 98007 (206) 644-7000	Washington, Oregon, Idaho, Montana, British Columbia, Alberta	4.8 million	4.5 million	73%
Pulse	Financial Interchange 600 Travis St., Suite 942 Houston, TX 77002 (713) 223-1400	Texas, Oklahoma, Louisiana, New Mexico, Arkansas	6.2 million	4 million	37%
Owl Network	Central Trust 5th & Main St. Cincinnati, OH 45202 (513) 651-8140	Ohio, West Virginia, Indiana, Kentucky	2.9 million	3.7 million	68%
Cash Station	Cash Station 1275 Davis Rd. Suite 0338 Elgin, IL 60120 (312) 272-6610	Chicago metropolitan area	600,000	2.9 million	61%
Honor	Florida Interchange Group Box 20636 Orlando, FL 32814 (305) 896-7786	Florida, Georgia	4.2 million	2.5 million	20%
Instant Cash	Norwest 255 Second Ave. South Minneapolis, MN 55479 (612) 372-7095	10 midwestern states	835,000	2.5 million	25%

THE TOP 5 NATIONAL NETWORKS

Cirrus	Cirrus 1333 Butterfield Rd. Downers Grove, IL 60515 (312) 960-9070	46 states	60 million	654,000	160%
Visa	Visa 80x 8999 San Francisco, CA 94128 (415) 570-3651	35 states	103 million credit cards	158,000	586%
Plus System	Plus System Box 5060 Denver, CO 80217 (303) 571-5172	47 states	70 million	1.1 million	75%
Express Cash	American Express 1 American Express Plaza New York, NY 10004 (212) 323-2000	36 states	23 million	Not available	Not available
Nationet	Nationet 15395 S.E. 30th Place Bellevue, WA 98007 (206) 644-5160	19 states	20 million	60,000	0%

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH/BANK NETWORK NEWS



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system in the next two years."

But Love notes that several strong regional switching companies are prepared for the battle, having built strong and efficient organizations. Foremost among them, he says, are the New York Cash Exchange, Pulse, Honor, Avail, Cash Stream, Most, and MAC. Such companies will gradually begin to absorb smaller networks to become domi-

or, and touch screens—options that may add an additional \$1,000 to the cost of a machine.

But all this automation hasn't eliminated one fact of life: you still must have enough money in the bank in the first place. ■

Barry Rosenberg is a free-lance writer specializing in science and technology.

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agreement that lets Visa-affiliated banks issue cards for the more than 10,000 Plus terminals across the country. Also, MasterCard's acquisition of Cirrus, the largest national network, is imminent.

Fighting off MasterCard and Visa are about 125 regional networks that grew up with automatic tellers in their areas. The national networks will be



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Network name

MAC

MPACT

XPress 24

CashStream

Exchange/Accr

Pulse

Owl Network

Cash Station

Honor

Instant Cash

Cirrus

Visa

Plus System

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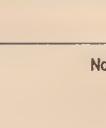
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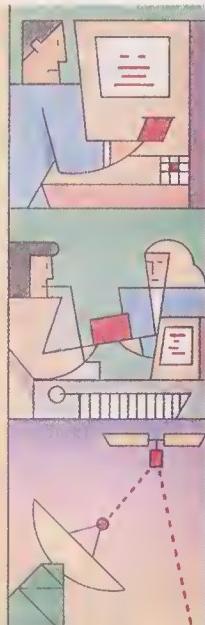
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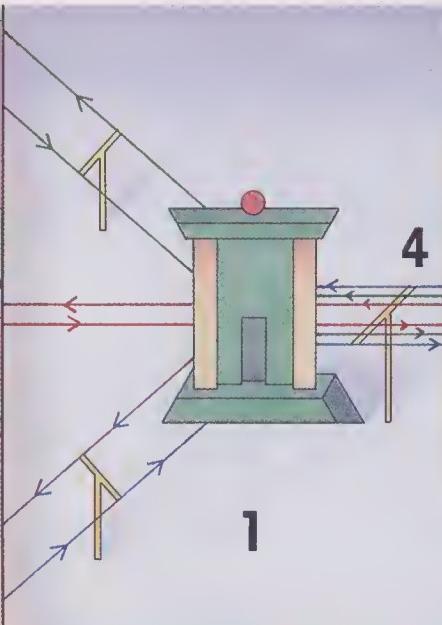
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The Electronic Flow of Money

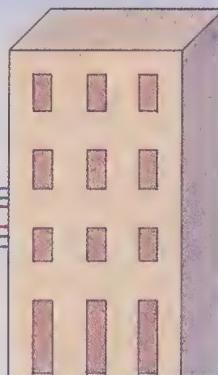
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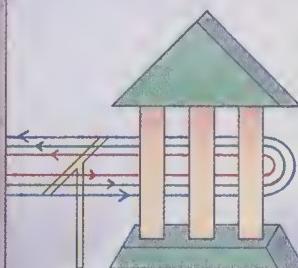
B



C



2



3

A Automatic teller machine
Customer inserts card,
enters ID number,
requests \$200 cash

B Point-of-sale terminal
Customer inserts card,
gives ID number, pays
\$200 to store

C Future prospects
In future, customer
will order tickets,
reserve hotel or car

1 Bank
Bank's mainframe
routes request to
network

2 Network company
Network's mainframe
checks data, sends
to customer's bank

3 Customer's bank
Bank verifies ID,
checks balance, sends
network \$200 credit

4 Network company
Network credits bank
or store with \$200
for \$200 from ATM

MARK FISHER

ates about 7,600 terminals at 2,800 locations, ranging from Lucky grocery stores to Wendy's fast-food stands.

Perhaps the most significant move for the networks is the creation of Entree, a trademark that will appear on MasterCard and Visa credit cards and give cardholders access to Entree point-of-sale terminals. The system is supposed to be in place next year. At that point, says John Love, publisher of the banking industry newsletters *Bank Network News* and *POS News*, "The battle for the point-of-sale business will really be on."

Credit-card transactions are not the direct-debit, electronic transfers used in point-of-sale. However, Visa and MasterCard's large and powerful national organizations give them a good base from which to launch a point-of-sale network. And they're very eager to get in. Their entry route is through the national automatic-teller networks—Visa is teamed up with Plus, under a special agreement that lets Visa-affiliated banks issue cards for the more than 10,000 Plus terminals across the country. Also, MasterCard's acquisition of Cirrus, the largest national network, is imminent.

Fighting off MasterCard and Visa are about 125 regional networks that grew up with automatic tellers in their areas. The national networks will be

able to charge banks low prices—less than four cents per transaction—as an incentive to sign on. However, regional networks offer services that national companies can't match. Foremost among them is local control, as regional switches are typically owned by the banks they serve.

"Networks were put together to satisfy the needs of banks," says Stanley Paur, president of Financial Interchange, of Houston, Tex.; his group operates Pulse, the largest regional network in the United States. "[Regional networks give] banks more control over their destinies."

Nevertheless, observers predict that many regional networks will consolidate as competition mounts. "The nationals are going to get their share, particularly in markets where there are weak regionals," says publisher Love. "I think we're heading for a 50-network system in the next two years."

But Love notes that several strong regional switching companies are prepared for the battle, having built strong and efficient organizations. Foremost among them, he says, are the New York Cash Exchange, Pulse, Honor, Avail, Cash Stream, Most, and MAC. Such companies will gradually begin to absorb smaller networks to become domi-

nant within larger regions, much as the Yankee 24 network is growing to dominate the electronic-transfer market in New England.

"It's not clear who's going to win nationally," says Briggs of Arthur D. Little. Like others who have watched the ups and downs of electronic transfer, he refuses to pick winners. But he favors Visa and MasterCard, plus the stronger regional networks that are mustering economies of scale.

Amid the elaborate plans for sophisticated electronic transfer of funds, what of the run-of-the-mill machine that calmly dispenses cash when you need it most? Even the lowly bank machine is getting attention. For example, NCR offers models that display as many as 15 different messages, tailored to individual banks. IBM manufactures machines that dispense coins, for cashing paychecks to the penny (a common feature in Japan). Omron and Fujitsu lead in computer graphics, color, and touch screens—options that may add an additional \$1,000 to the cost of a machine.

But all this automation hasn't eliminated one fact of life: you still must have enough money in the bank in the first place. ■

Barry Rosenberg is a free-lance writer specializing in science and technology.

Phone Companies Gamble on Technology

*Massive startup costs cripple the search
for growth in new ventures*

BY FREDRIC PAUL

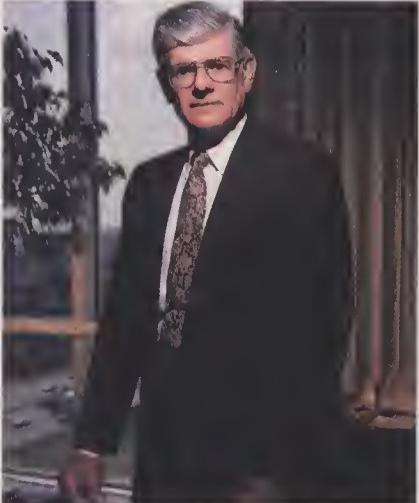
IN THE UNITED States, nearly everyone who wants telephone service already has it. What's a phone company to do?

The only way to find new revenues, many local phone companies have concluded, is to sell customers something besides basic phone service. An all-out lunge toward diversification has led these companies into startups, joint ventures, and acquisitions in everything from cable TV to long-distance service, from selling telecommunications equipment to offering cellular mobile-phone service.

So far, such technologically advanced ventures have lured large phone-company investments. For example, GTE and United Telecommunications have put almost \$2 billion into a new fiber-optics network for US Sprint Communications. However, in at least some cases, costs associated with such technology have given the new ventures swimming lessons in red ink.

"I don't think [diversification] has been a resounding success," says Richard Donofrio, senior vice president of Southern New England Telecommunications Corp., serving Connecticut.

The push toward diversification became inevitable with the breakup of AT&T and the onset of deregulation in 1984. Suddenly, phone companies that had enjoyed monopolies on local service



GTE's Don Mitchell pins his hopes on new services, not on troubled Sprint.

were threatened by new technological capabilities that could steal away their most lucrative customers. Such fresh options as direct satellite connections, teleports, and private networks mean that local phone companies can no longer count on being the only telecommunications gateway for large customers.

Regulatory prescriptions keep the seven regional Bell holding companies, which provide the lion's share of the nation's local service, out of many new businesses, leaving the field to the independents, at least for now.

US Sprint, owned by the two largest non-Bell phone companies, is by far the biggest diversification venture attempted by the independents. It is also the largest of the long-distance money losers; Lap Lee, an analyst at Salomon Bros., says Sprint's \$1-billion-plus losses offset any profits from diversified activities in the rest of the industry.

Formed in mid-1986 to challenge AT&T by combining the marketing muscle of GTE Sprint with the concept of an all-fiber-optic network envisioned by United's US Telecom subsidiary, the new company bargained that digital lightwave technology will distinguish its service from that of market leader AT&T, which uses a mix of microwave, satellite, and lightwave connections. MCI, originally Microwave Communications Inc., still relies largely on microwave transmission as well as owned and leased fiber-optic lines.

US Sprint, starting from scratch, hoped to leapfrog directly to lightwave transmission, using lasers to shoot beams of light through fiber-optic cables about the thickness of a human hair. As in other modes of transmission, these beams are modulated to carry information, but their much higher frequency means they can carry more information faster, more cheaply, and with less noise than other transmission methods.

BOB WAGNER

US Sprint's new network is also designed to be 100 percent digital, carrying both voice and data as binary signals rather than as analog waveforms; this is expected to cut distortion and noise.

Begun in 1984 with a budget of about \$2 billion, construction of the 23,000-mile fiber-optic network was to have been supported by revenue from US Sprint's ongoing operations. Although the company claims the network is on time and within budget, problems with revenue and customer billing have sent losses spiraling. And, because fiber-optic cables must be laid along the ground, construction costs and delays have been troublesome.

Despite the costs, a nationwide fiber-optics network holds the only real chance for US Sprint—or any alternative carrier—to break AT&T's stranglehold on the market. When completed, the transmission superiority of the new network will for the first time let US Sprint compete on a basis other than price—still the only real selling point for alternative long-distance carriers. The company hopes to stem many of its losses in the second half of 1987.

Although observers agree that US Sprint's fiber network will give it a competitive advantage, many worry it will be too little, too late. Don Mitchell, GTE's vice president of planning and development, admits that under current regulations, "In retrospect, it's a market we might not have been so excited about entering."

United, also hit hard with Sprint's losses, shrugs off the situation. "We've had some hits and misses," says Don Forsythe, vice president of corporate communications. He refuses to call US Sprint a miss, claiming the troubled operation can still be turned around.

Long-distance service has been a money sink for other independents as well. Southern New England Telecommunications (SNET) had startup problems with its Lightnet operation, which was designed to sell fiber-optic capacity to other carriers. Also, Alltel and Centel

Jack Frazee, president of Centel, balances equipment losses with a cable-TV winning streak.

were forced to write off investments in the Argo Group, a small regional carrier, when its merger with Litel Telecommunications and Microltel fell through last year.

But if long distance has been the most disappointing area, manufacturing and selling telecommunications equipment has fared little better. GTE became so discouraged with the business that it sold a majority interest in its PBX-manufacturing operation to Japan's Fujitsu Ltd. and handed control of its transmission and international switching business to Germany's Siemens AG. GTE also is negotiating to sell its computer-chip manufacturing operation to California Microdevices. Bell company competition forced SNET to abandon its attempt to sell equipment outside its home state of Connecticut,

and Centel is considering selling its troubled Executone subsidiary.

Jack Frazee, Centel's president, retains his confidence in the long-term wisdom of his company's recent purchase of the midwestern distribution arm of giant telecommunications-equipment manufacturer Northern Telecom. However, he acknowledges that changeover costs incurred by the purchase have left that division in the red.

Although long-distance service and equipment sales have suffered, GTE, for one, remains optimistic about several areas that involve advanced technology, especially enhanced services.

These businesses are currently handcuffed by severe regulatory restrictions. Down the line, GTE—as well as the Baby Bells—hope sophisticated switching and signaling capabilities of



DAVID WAGENAA

THE SEVEN TOP INDEPENDENTS DIVERSIFY

COMPANY	GTE	United	Contel
1986 REVENUE	\$15.1 billion	\$3 billion	\$3.1 billion
NUMBER OF ACCESS LINES	11.1 million	3.4 million	2.3 million
TECHNOLOGY VENTURES	<ul style="list-style-type: none"> ■ Long distance (50% owner, US Sprint) ■ Cellular service (GTE Mobilenet) ■ Paging (GTE Telemessenger) ■ Airline phones (GTE Airfone) ■ Satellite communications (GTE Spocenet) ■ Telephone-equipment manufacturing and sales (GTE Communications Systems; GTE Consumer Communications) 	<ul style="list-style-type: none"> ■ Long distance (50% owner, US Sprint) ■ Cellular service (United Telespectrum) ■ Computer graphics (MegaTek) ■ Electronic yellow pages (Information Line) ■ Financial systems software (Information Systems of America) 	<ul style="list-style-type: none"> ■ Satellite communications (Contel ASC; including Equatorial and parts of Comsat) ■ Multiuser computers (Contel Computer Systems) ■ Telecommunications and tracking systems (Contel Federal Systems) ■ Data-network services (Comsat International Communications) ■ Cellular service (Contel Cellular)
OTHER VENTURES	<ul style="list-style-type: none"> ■ Telephone-equipment distribution (GTE Supply) ■ Yellow pages (GTE Directories) ■ Electric bulbs and lamps (GTE Lighting) ■ Materials and components (GTE Precision Materials) 	<ul style="list-style-type: none"> ■ Telephone-equipment distribution (North Supply) ■ Yellow pages (Directories America) ■ Home security systems (United Telesentinel) 	<ul style="list-style-type: none"> ■ Telephone-equipment sales and distribution (Contel Executive, Contel Business Networks, Contel Texocom) ■ Financial services (Contel Credit) ■ Financial-trading systems (Contel IPC) ■ Shared tenant services (Contel Tenant Services)
Every company has different criteria for what it considers diversified business. These are the major diversification efforts of the seven largest independent telephone companies.			
GTE 1 Stamford Forum Stamford, CT 06904 (203) 965-2000		United Box 7927 Overland Park, KS 66207 (913) 345-6000	Contel 245 Perimeter Center Pkwy. Atlanta, GA 30346 (404) 391-8000

ferred by the new digital networks will squeeze additional profits out of the existing phone network.

The most promising services include database retrieval—providing access to centralized information sources and delivering relevant information along with phone calls. Such a service could prove invaluable for telemarketing and order-entry operations. Also on the way are voice-message services, which attack the fast-growing answering-machine market; teleconferencing; and videotex, which offers users access to third-party information services.

According to GTE vice-president Mitchell, these enhanced services are GTE's most important diversification business because they build on the company's basic phone network.

Cellular radio service is also generating a lot of interest among phone companies as an expansion target. This service became a reality with the advent of computer technology that enabled switches to hand off callers from one "cell" to another, increasing capacity by allowing simultaneous calls over the same frequency.

But because cellular phones are two-way radios as well as telephones, they cost more than ten times as much as standard phones, and a mass market seems to be waiting for lower prices from consumer-electronics companies.

Also, poor service quality could stand in the way of the cellular phone becoming a mass-market product. Customers used to reliable home phone service are not likely to stand for still-common service glitches while the technology evolves, no matter what the price.

Despite such problems, cellular service seems to be the most promising area for diversification. Lee of Salomon Bros. says everybody is in cellular "to the extent they possibly can be."

Among the independents, major players to join up since the first cellular system went into operation in October 1983 include Alltel, Contel, GTE, and SNET.

Alltel draws an estimated 15 percent of its revenue from cellular operations. Although its cellular service is still in the startup phase, "We can see clearly that's going to be a very good business for us," says Ronald Payne, vice president of investor relations. The company expects to reach the break-even point within 18 months and begin a five- to ten-year period of high growth.

Contel is also active in cellular and is looking to expand its cellular operations via takeovers. SNET, which supplies cellular service in Connecticut, offers it because it's "just like regular service," says vice president Donofrio.

Mobile services are also a key part of GTE's strategy. In addition to operating several cellular-phone systems, the

company last year bought Airfone, which uses a cellular-like system and special radio phones equipped with credit-card readers to provide service from commercial aircraft. GTE's Mitchell expects Airfone to have equipment on 600 planes by the end of the year.

Long-distance service, cellular service, and equipment sales are the three most popular spheres for diversification, but some of the most successful and promising areas are being explored by individual companies.

For Contel, the nation's third-largest independent, the sky's the limit. Shrugging off the collapse of its proposed merger with Communications Satellite Corp. (Comsat), Contel recently agreed to buy Equatorial Communications, which makes very small aperture terminal (VSAT) earth stations.

Along with Comsat's VSAT operations, which Contel acquired as a sort of consolation prize when the merger turned sour, Equatorial turns the phone company into the major player in the promising low end of the satellite earth-station business. New president and CEO Don Weber acknowledges that VSATs represent "a new direction" for Contel and are not yet profitable, but says the company is "intrigued with the possibilities of the market."

Low-end VSAT networks use small terminals, typically less than six feet in

SNET	Centel	Alltel	Cincinnati Bell
\$1.4 billion	\$1.4 billion	\$697 million	\$492 million
1.7 million	1.3 million	954,000	662,000
<ul style="list-style-type: none"> ■ Cellular service and retail sales (SNET Cellular and SNET MobileCam) ■ Fiber-optics carrier (SNET FiberCom in joint venture with CSX for Lightnet) ■ Fiber-optics manufacturing (Sonetran joint venture with SpecTran) 	<ul style="list-style-type: none"> ■ Cable television ■ Cellular service (Centel Cellular) ■ Data-communications products (M/A Com Information Services) ■ Long distance (minority interests in Litel Telecommunications and Microtel) 	<ul style="list-style-type: none"> ■ Cellular service (Alltel Mobile Communications) ■ Paging (Alltel Mobile Communications) ■ Long distance (minority interests in Litel Telecommunications and Microtel) ■ Telephone-equipment manufacturing (minority interest in Comdial) 	<ul style="list-style-type: none"> ■ Software systems for telecommunications billing and management (Cincinnati Bell Information Services) ■ Cellular service (minority partner with Ameritech Mobile Communications) ■ Printed-circuit repair (Restor)
<ul style="list-style-type: none"> ■ Telephone-equipment sales (SNET Systems) ■ Yellow pages (SNET Publishing) ■ Financing (SNET Credit) ■ Real estate (SNET Real Estate) ■ Management and development (SNET Diversified Group) 	<ul style="list-style-type: none"> ■ Telephone-equipment sales (Centel Business Systems) ■ Telephone-equipment distribution (Centel Supply) ■ Electric utilities 	<ul style="list-style-type: none"> ■ Telephone distribution (Alltel Supply) ■ Yellow pages (Alltel Publishing) 	<ul style="list-style-type: none"> ■ Retail computer sales (Abucus Computer Systems) ■ Telephone-equipment distribution (Cincinnati Bell Material Services; with Anixter Bras.) ■ Used telephone equipment (Cincinnati Bell Material Recycling)
<ul style="list-style-type: none"> ■ Southern New England Telecommunications 227 Church St. New Haven, CT 06510 (203) 771-5200 	<ul style="list-style-type: none"> ■ Centel O'Hare Plaza B725 Higgins Rd. Chicago, IL 60631 (312) 399-2500 	<ul style="list-style-type: none"> ■ Alltel 100 Executive Parkway Hudson, OH 44236 (216) 650-7000 	<ul style="list-style-type: none"> ■ Cincinnati Bell 201 E. Fourth St. Cincinnati, OH 45201 (513) 397-7B77

diameter, to bounce signals off communications satellites. One-way systems are typically used to send information from one point to a number of other sites. More sophisticated two-way systems allow the branches to talk back.

Such networks provide cost-effective data communications for companies with more than 100 locations, such as oil companies and gas stations, hotel chains, and franchise operations.

The one-way, point-to-multipoint business has been successful because of the economies. Instead of paying for calls to 200 branch offices, a company can send one message to the satellite, which transmits it to all branches at once. The advantages are even more pronounced when offices are widely scattered; savings of as much as 50 percent over terrestrial systems are said to be common.

Despite fast growth, however, the VSAT industry has not lived up to expectations. Analysts now predict 15 percent annual growth, down from recent projections of 50 percent growth. Bugs in the software designed to link the varying communications protocols of the terminals, mainframes, earth stations, and satellites have shaken players' faith in the technology. Weber still predicts the VSAT market will hit \$500 million by the early 1990s.

Equatorial has sold about 37,000

VSATs since its inception in 1979, mostly the relatively simple one-way systems. But the company has suffered losses related to development costs of its new two-way systems.

As Contel reaches for the sky, Cincinnati Bell, which serves the Cincinnati area, has "no illusions about its size or resources," says Dennis J. Sullivan Jr., CFO and head of the company's diversified operations. It developed a niche selling computerized management and billing software and services to other phone companies, and to large companies that operate their own phone networks. The result has been one of the most successful diversification efforts in the industry.

The data-processing and software expertise needed to run the business was originally developed for Cincinnati Bell's in-house use, but has been spun off into a lucrative growth opportunity.

Cincinnati Bell Information Systems (CBIS), the unit that developed the business, grossed over \$100 million in 1986 and has turned a profit for three years running. To push the move into the cellular market, Cincinnati Bell last year acquired Cellular Business Systems. This year Cincinnati Bell bought Auxton Computer and Creative Management Systems, both of which will add new billing and management customers and expertise. Today, CBIS sells to

customers ranging from British Telecom to Telecom Australia.

Not surprisingly, expansion into proven technology has led to proven profits. Centel's move into cable television has probably been the industry's most successful diversification effort; its cable-TV operations doubled their earnings last year, and now account for about 10 percent of total revenues and most of the company's growth.

At first glance, expanding into cable TV may seem to fly in the face of the conventional wisdom that phone companies should stick close to the local-service business. But Centel president Frazee says, "To me, they're the same business" in that they both are communications franchise service businesses.

Centel got into cable TV through acquisitions and plans to acquire more. Although the company has met its goal of 500,000 subscribers, "We don't plan on stopping there," says Frazee.

Despite the problems, the industry is still optimistic about its expansion into new fields. Contel's Weber admits the industry has "been judged a failure at diversification" so far, but claims it's too early for a final judgment. He says "it's a big learning process" to sort out what phone companies are equipped to do and what they aren't. "I think we're still five years away from saying, 'Yes, it was a successful endeavor.'"

GM Vice Chairman Donald J. Atwood

ON THE NEW AUTO INDUSTRY

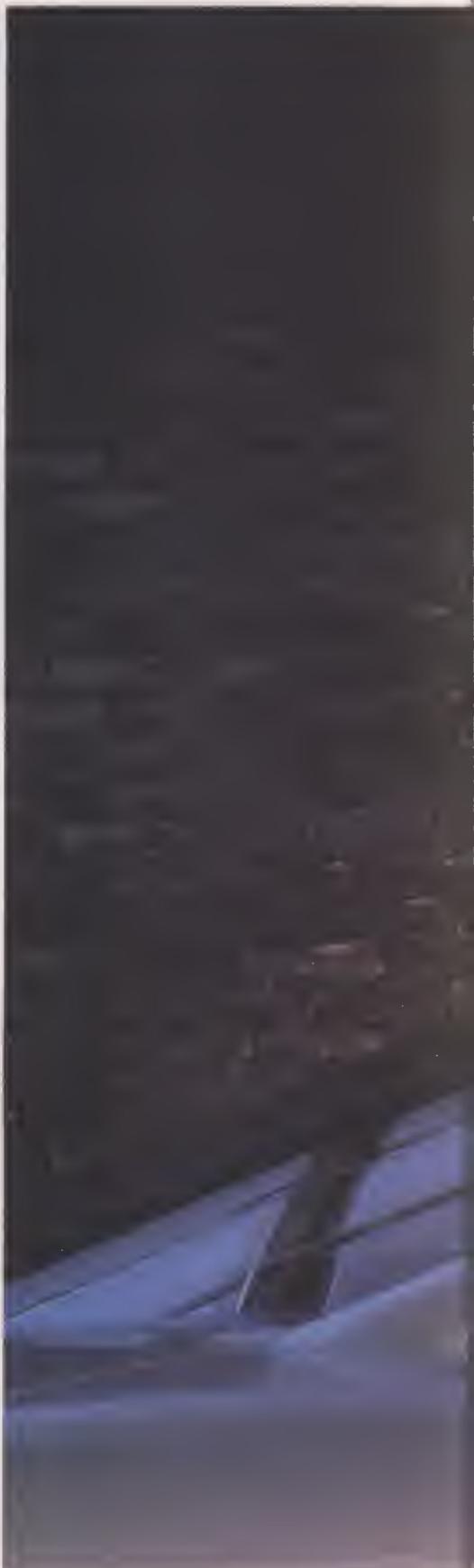
GENERAL MOTORS is the world's largest corporation; its purchases and sales of technology affect countless other companies around the world. Donald J. Atwood, at age 63, sits atop the highest of GM's high-tech operations: As vice chairman since May, he is responsible for the company's Electronic Data Systems, GM Hughes Electronics, and the Defense Operations Group.

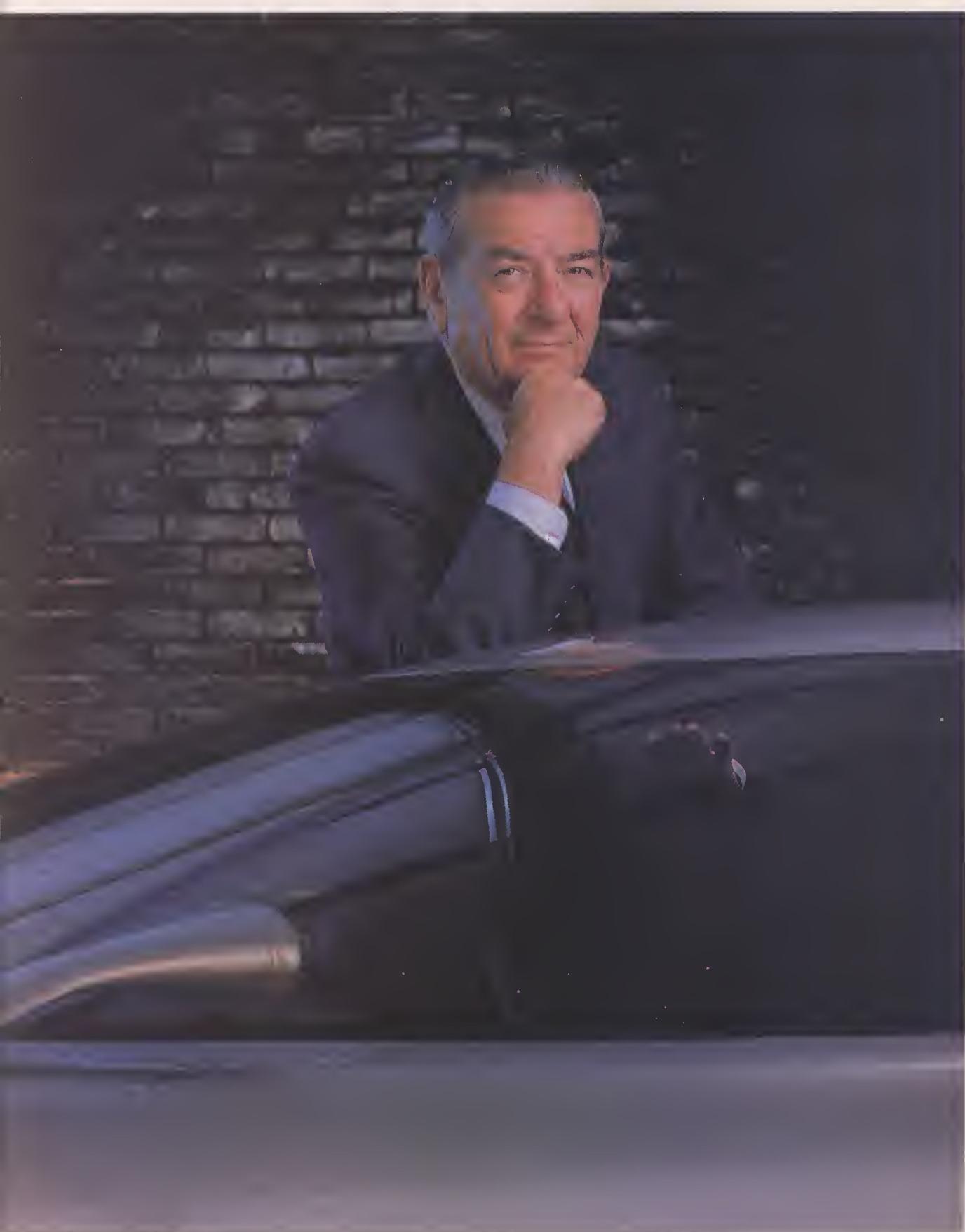
Even with record \$103-billion revenues in 1986, all is not rosy for the industrial giant. GM's net income for the year, just under \$3 billion, put it behind archrival Ford Motor in earnings, even though Ford's revenue was about 40 percent less. The company is still reeling from massive capital expenditures to upgrade aging plants, and to develop new products that keep pace with rapid changes in the auto industry.

For October, when the Detroit corporation typically trumpets its new models, HIGH TECHNOLOGY BUSINESS assistant managing editor Jeffrey Zygmont talked to Atwood about the sobering realities facing American automakers.

■ *HT Business: During the last recession, many were predicting the demise of the U.S. auto industry. Since then the economy has given you some respite, but is the day of reckoning still coming?*

Atwood: Our biggest mistake would be to mislead ourselves into thinking that we now have our problems solved, just because the economy has turned around and our profits have grown. We have to recognize that, in this fiercely competitive





KEVIN HORAN

market, we'd better be there with the most advanced technology in both our products and plants. Companies that have taken steps to fix the basic problem—that have improved their products and done something about their manufacturing—are probably going to be in great shape. Most of the companies that I see recognize that and have taken or are beginning to take the necessary steps. The only shakeout will be for the companies that still ride on the old philosophy that they can go up and down with the economy.

■ *HT Business: What has changed to make that philosophy obsolete?*

Atwood: Today the U.S. market is fiercely competitive with overseas manufacturers, from both Europe and the Far East. A marketplace that was once very heavily populated by Ford, Chrysler, GM, and American Motors now includes Far East manufacturers like Toyota, Nissan, Hyundai, Daewoo. Then of course there are the European companies like Volvo, Mercedes-Benz, and many others.

■ *HT Business: Do you expect this international competition to intensify?*

Atwood: I think the trend probably will slow, particularly in the face of the changing value of the dollar relative to currencies of other countries. The North American market, including Canada, was attractive when the dollar was particularly strong and other countries' currencies were weaker. Now overseas manufacturers must accept lower profits, or raise their prices, making them less competitive here.

We will probably see a growing number of overseas manufacturers building plants in this country. We're already seeing that with the Japanese.

■ *HT Business: Doesn't that threaten the traditional U.S. auto companies?*

Atwood: Well, if you're speaking of just one company, its market share is threatened as foreign manufacturers come over. But it also means that they will be incorporating more American-made components in their cars. I think that's good for the overall auto industry, if they manufacture here and use American components.

■ *HT Business: So the U.S. has grown into an intensely competitive international market. Where does technology fit in?*

Atwood: It's my conviction that, increasingly, high technology is the future of the automotive industry. To be competitive, any automobile manufacturer must incorporate the latest state-of-the-art technology, both in its products and its factories. In the factory, competitiveness requires great, continuing improvements in quality, and great, continuing reductions in costs. These requirements will be reached by the incorporation of advanced technology in factories.

■ *HT Business: Does that portend increased spending on high technology from GM?*

Atwood: We feel that we've already done that. We have made investments in high-technology companies, and are in the process of reaping what we have sown. We have made investments in our factories—with the building of new factories, with the renovation of our older factories, and the incorporation of many very advanced paint systems, robotic welding systems, automated guided vehicles, and so on.

Obviously, we continue to upgrade. I don't mean to imply that it's done once and it's over. It requires a continuing upgrade, but we have taken the big step.

■ *HT Business: But GM has taken a lot of criticism about the failure of some of its automation programs.*

Atwood: Let me explain the situation. In a highly automated plant, you have automated robotic welding systems, automated guided vehicles, an automated assembly process, and an automated paint setup. It's one advance just to build these individual units or cells so that they work independently. But it's another thing to get all of them to work together. So I think we've come a long way from the original concept, which evolved from treating individual items within a plant to now taking a total systems approach. Integration is the big step.

■ *HT Business: How are new competitive pressures affecting the relationship between carmakers and suppliers?*

Atwood: We cannot be a successful company with a series of unsuccessful suppliers. In other words, if we're going to buy components, they have to be world-class components—in quality, reliability, and competitiveness. So any supplier who wants to continue in this business must also be world class. Therefore there's been the same kind of revitalization of the

■
“No longer can
car companies buy
their parts from
the lowest bidder.”
■

supplier industry. Companies have made major strides.

No longer can car companies buy their parts from the lowest bidder. We have to work with suppliers very early in the design process. They help us design components less expensively and with better quality. Otherwise you won't incorporate the best into your car.

General Motors has been very vertically integrated, building up to 70 percent of its own components itself. We're taking a close look at that. We want to make sure that all of the components that we get are world class, and we're looking very heavily to outside suppliers to do this with us. We're using those stronger companies to provide what we want, in some cases purchasing components we had made ourselves.

We might buy something that is highly labor intensive, or something in a technology that is not our main forte.

■ *HT Business: GM's 1985 purchase of Hughes Aircraft gave it access to sophisticated aviation technology. When will GM cars begin to reflect that technology?*

Atwood: A lot of people expect to see Hughes products in their cars. That isn't the case. It's the technology and the know-how that gets into the car, and that gets into the plant. But what we're trying to do is transfer know-how, not design a product for Hughes to put into a car.

The way we've approached it is to take the executive vice president of Hughes Aircraft—who is responsible for technology—and also put him in charge of Delco Electronics so that he has one foot in General Motors and one foot in Hughes. We put the technology-transfer responsibility under him. He has a full-time person who heads up a series of teams composed of both Hughes and General Motors people. Teams work on specific technologies that we want to transfer. I am amazed by the number of teams we have going.

■ *HT Business: Have you seen any results yet?*

Atwood: It is working well. We are already seeing the benefits of this. The technology General Motors has today is a significant improvement over what it could have had without Hughes, even if GM made major investments in trying to develop the technologies itself.

■ *HT Business: Will GM continue to buy companies to acquire their technical expertise?*

Atwood: We made major acquisitions of Hughes Aircraft and Electronic Data Systems (EDS); we are not contemplating any more acquisitions of that nature. We did make some equity investments in a series of smaller companies working on things like machine vision and artificial intelligence. Those were not takeover acquisitions; they were minor equity investments in which we gave research-and-development funding. We were looking for technology, and we continue to look for opportunities where we can gain technology by becoming a partner.

We really want to make sure we have the latest, state-of-the-art technology. In our Delco Electronics Division, to get the latest in integrated-circuit design, we formed business relationships—not joint ventures but three- to four-year contracts with a number of integrated-circuit companies like Texas Instruments, National Semiconductor, and Motorola. We will buy their integrated circuits provided they continue to do the development and design. It's a good source of business for them, and a great source of technology for us.

■ *HT Business: Texas Instruments, National Semiconductor, and Motorola are large companies. Where do small companies fit into your plans?*

Atwood: I think there will always be room for the entrepreneur who has an idea and goes out and develops it. I came to General Motors that way. Out of M.I.T., I had my own small company and I did work for General Motors and General Electric. I ultimately joined GM as a result of that.

Small companies often have greater flexibility, good ideas, and the willingness to put them to work. If the day comes when we don't recognize that, we're in deep trouble.

■ *HT Business: GM's acquisitions have led the corporation into a number of new markets. Are they the start of diversification?*

Atwood: The primary reason we bought EDS and Hughes was to take advantage of their technology for our principal business, which is cars and trucks. To me, they mean we should be in the forefront of technology in office automation,

"**T**here will always
be room for the
entrepreneur who
develops an idea."

information processing, computer-aided design and engineering, computer-integrated manufacturing, and communications. Hughes brings a technical capability to our products, so we should be among the leaders in technology.

It was a tremendous opportunity to be able to buy complete companies that had growing businesses. We want those companies to continue to grow and prosper in their fields. We formed a high-technology, defense, and electronics business unit that consists of Hughes, Delco Electronics, EDS, Allison Transmission, and Gas Turbine divisions, and a number of other operations. This business unit does annual sales of about \$18 billion, and about \$7.5 billion of it is in defense. That's a substantial amount of business—we're about the fifth largest defense contractor in the U.S. It's a wonderful diversification, but that isn't why we're in it.

■ *HT Business: It seems that U.S. automakers are giving up on manufacturing small cars, opting to import them from Japan and elsewhere. Will the day come when all small cars sold in America are from overseas?*

Atwood: We are developing the Saturn concept, which is our move to prove that we can be competitive in the small-car market in the United States. Heretofore, the domestic manufacturers have not been. We believe the Saturn concept is going to be a remarkable step forward. Therefore we see our import agreement with Isuzu and Suzuki, and our joint manufacturing venture with Toyota [in Freemont, Calif.] probably continuing, but we're not enlarging them. We are developing our own small-car manufacturing capability too.

■ *HT Business: Saturn is a GM subsidiary formed to manufacture a small car in the early 1990s. But what is "the Saturn concept?"*

Atwood: We took a whole new approach to business in the small-car market, dealing not just with technology but also with people. Working hand-in-glove with the United Auto Workers union in a unique contractual arrangement, we set up a separate corporation that isn't strangulated with all of the procedures and history incorporated in General Motors. Then Saturn developed a self-contained manufacturing process.

■ *HT Business: That "history" has led GM to the number-one rank in the industrial world.*

Atwood: We hope to keep it that way. I would be less than candid if I didn't tell you that the whole thrust of our technology is to keep us there. I think we're making great strides. ■



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MARKET WATCH

NEW COMPANIES

COMPANY (STOCK SYMBOL)	BUSINESS OBJECTIVE	FINANCING	OFFICERS	OFFICERS' PREVIOUS POSITIONS
Criticare Systems (CR5Y) 80x 26556 Milwaukee, WI 53226 (414) 797-8282	To make noninvasive, portable monitors of oxygen and carbon dioxide.	\$6.6 million from initial public offering	Gerhard J. Von Der Ruhr, president N. C. Joseph Lai, v.p. of R&D Richard J. Osowski, v.p. finance	Biochem International, co-founder Biochem International, v.p. of R&D General Split, controller
Data Technology (DTCI) 2551 Walsh Ave. Santa Clara, CA 95051 (408) 722-8899	To design, develop, and market intelligent storage controllers and chip sets for IBM-compatible computers.	\$21 million from initial public offering	David S. Lee, chairman, president, CEO David O. Tsang, vice chairman, exec. v.p. storage-subsystem products, director Franklin S. Shoh, exec. v.p. disk-drive products	ITT Quimex, co-founder, v.p., group executive Xebec, v.p. ITT Quimex, v.p. technology
Delphi Info. Systems (DLPH) 31416 West Agora Westlake Village, CA 91361 (818) 706-8989	To provide services and software to automate insurance-agency management, including claims, policy serving, accounting, and word processing. Products also include hardware.	\$3.2 million from initial public offering	Walter Bauer, chairman, CEO Richard Jonssen, president, COO Mike McConnell, CFO	Informatics, chairman and president Informatics, founder, CEO Oak Leaf, CFO
Digital Microwave (DMIC) 170 Rase Orchard Way San Jose, CA 95134 (408) 943-0777	To provide microwave systems for short-haul communications. Products connect central offices, interconnect communications products, link private users to long-distance carriers, and connect data terminals to remote computers.	\$24 million from initial public offering	William E. Gibson, president, CEO P. Michael Friedenbach, chairman, CFO Robert E. Friess, exec. v.p.	Harris, v.p., general manager Private investor Harris, v.p. engineering
ECAD (ECAD) 2455 Augustine Dr. Sunnyvale, CA 95054 (408) 727-0264	To supply software that verifies, lays out, and simulates integrated-circuit designs. Products include Oroculo, Symbod, and Simon software.	\$11.3 million from initial public offering	Glen M. Antle, founder, chairman, CEO James A. Hill, president, COO Yen-Son Huang, founder, exec. v.p.	Gould/SEL Computer Systems Div., director microelectronics products Hill Technology Resources, consultant Gould/SEL, CAO section
EcoGen (ECN) 2005 Cabot Blvd. West Langhorne, PA 19047 (215) 757-1590	To develop pesticides from naturally occurring microorganisms; products eliminate or control insects, diseases, and weeds that threaten gardens or crops.	\$15.9 million from initial public offering	Harold V. Smith, founder, chairman John E. Oovis, president, CEO Bruce C. Carlton, v.p. of R&D	Synertech Group, principal Rhone-Poulenc, v.p. University of Georgia, professor of molecular and population genetics
Flow Vision Box 2307 Clifton, NJ 07015 (201) 478-4800	To manufacture on-line analyzers for pharmaceutical and industrial use. Products include a system that detects, counts, and measures particles and/or gels in fluids, and an infrared system that measures the percentage of substance in fluids.	Parent company, Modern Plastics Machinery, sold for startup funds; amount not disclosed	Larry Kilian, president Bill Provosco, v.p. engineering Steve Weiss, v.p. marketing	MPM, president MPM, v.p. engineering MPM, v.p. marketing
Health Technology 430 10th St., Suite N-102 Atlanta, GA 30318 (404) 461-1951	To develop a noninvasive, hand-held, microwave device that determines a person's pulse, respiration, and possibly temperature; product introduction planned in one year.	Pending; company is seeking \$250,000 to \$300,000	Douglas Robinson III, COO	Biomedical consultant to physicians and hospitals
Impact Systems (MPAC) 1075 E. Virokow Rd. San Jose, CA 95131 (408) 293-7000	To supply computer-based systems for paper manufacturing. Systems measure lag diameter and control weight and moisture content.	\$10.4 million from initial public offering	Ken Oftrow, president Norm Winton, COO Rajeeva Sharma, v.p. marketing	Measurex, senior v.p. Measurex, v.p. international sales Allied Material, manager of systems analysis

■ MARKETWATCH ■

COMPANY (STOCK SYMBOL)	BUSINESS OBJECTIVE	FINANCING	OFFICERS	OFFICERS' PREVIOUS POSITION
Intelligent Electronics (INEL) 33 East Uwchlan Ave., Suite 300 Exton, PA 19341 (215) 524-1820	To operate 76 franchise stores—Today's Computers Business Centers (TCBC)—that market microcomputer systems, services, and products, focusing on office products.	\$10 million from initial public offering	Richard O. Sonford, founder, president, chairman William G. Alvis, president of TCBC Norman Shopero, v.p. marketing	Commodore International, exec. v.p. IBM, quality assurance and national distribution Tandy, Philadelphia region manager
Interspec (ISPC) 1100 E. Hector St. Conshohocken, PA 19428 (215) 834-1511	To sell and manufacture ultrasound systems and accessories for physicians and hospitals.	\$13.3 million from initial public offering	Bernard D. Steinberg, chairman Edward Roy, president, CEO William P. Merritt, v.p., president of Echo Ultrasound division	University of Pennsylvania, director of Research Center Air Shields, president GE, president of Echo Ultrasound
I-Trek 710 E. Pork Blvd., Suite 204 Plano, TX 75074 (214) 578-8104	To produce personal-computer software; products include information-tracking and hard-disk-management software for the IBM PC-XT/AT and compatible computers.	About \$1 million from founders	Forest W. Speer, president, chairman, CEO William Hinshaw, exec. v.p. Jon Bonner, v.p. sales and marketing	Signature Technology, founder Hinshaw Software, president, owner Vomco, president
Komeg (KMAG) S91 Yosemite Dr. Milpitas, CA 95035 (408) 946-2707	To sell $5\frac{1}{4}$ -in. disks for Winchester drives; company uses a sputtering technique to lay thin films on disks.	\$34 million from initial public offering	Tu Chen, chairman Steve Johnson, president, CEO Scott Chen, v.p. quality	Xerox, principal scientist Boschert, president, CEO IBM, engineering manager
MicroAge (MICR) 2308 S. 55th St. Tempe, AZ 85282 (602) 968-3168	To act as a franchising agency in the computer industry. Franchisees and a MicroAge subsidiary sell personal computers, software, and peripherals.	\$11.5 million from initial public offering	Alon P. Hold, chairman Jeff McKeever, president, CEO James Manton, COO	First Interstate Bank, development, marketing First Interstate Bank, v.p. White Motor, supervisor production material control
Mycogen (MYCO) 5451 Oberlin Dr. San Diego, CA 92121 (619) 453-8030	To make pesticides based on microorganisms for commercial formers.	\$16 million from initial public offering	Jerry D. Coulter, president, CEO Andrew C. Barnes, v.p. business Albert Kern, v.p. commercial development	Monsanto, director new business and commercial development Genetics, president Monsanto, manager product development
Nellcor (NELL) 25495 Whitesell St. Hayward, CA 94545 (415) 887-5858	To produce an electronic patient-monitoring device that measures oxygen and carbon-dioxide levels.	\$23 million from initial public offering	William New Jr., chairman Lester John Lloyd, president, director Robert S. Smith, v.p. and CFO	Stanford University School of Medicine, professor Humphrey Instruments, president Humphrey, v.p.
Poroquest 890 Upland Dr. Lafayette, CA 94549 (415) 284-9723	To evaluate, design, install, and support telecommunications systems in small to midsized companies.	\$50,000 to \$100,000 from founders	Roderick W. Ford-Smith, president Robert O. Taylor, v.p. Ovid Williams, director of engineering and field services	Rockwell International, regional sales manager Chevron, data communications manager KSGO radio/TV, chief engineer
Rise Technology (RTEK) 1 Kendall Square Cambridge, MA 02139 (617) 491-6601	To design, manufacture, and market computer-aided publishing systems for photographic-image applications.	\$6.35 million from initial public offering	Richard B. Block, chairman, director Alice d'Entremont, president, treasurer, director Robert J. Schiller Jr., v.p. administration, general counsel, director	R. Block & Associates, current owner Polaroid, principal engineer Schiller, Pondiscio & Kusmer, patent lawyer
Somno (SMNA) 2700 N.E. Expressway, Suite 700C Atlanta, GA 30345 (404) 321-5006	To develop software; current product is the Somno Word IV word-processing and graphics program.	\$3.6 million from initial public offering	Said Mohammadioun, chairman Marc Bailey, president Thomas Anderson, v.p. sales	Lonier Business Products, director of development Informatics, v.p., general manager legal systems Lonier, v.p. marketing
Wilkes Technologies 910 Main St. North Wilkesboro, NC 28659 (919) 667-6629	To design and install automated phone services for companies. Offers SupportCall, a system that answers calls and asks questions to determine who should return the call.	Not disclosed	Edward Gobol, president Jerry Whelon, v.p., director technical operations Pieter Von Der Toorn, v.p., director marketing and strategic planning	Northwestern Bank, planner analyst AT&T, director of desktop publishing Liof, U.S. acquisitions

JOINT VENTURES

COMPANY	COMPANY	PURPOSE	CONTACT
Dartmouth College	Essex Chemical	To commercialize monoclonal antibodies developed by Dartmouth for diagnosing and treating cancer and such autoimmune diseases as AIDS.	Dartmouth, Industrially Sponsored Research Hanover, NH 03755 (603) 646-3017
Display Components	Manitronics	To manufacture and market high-performance manachrome and color CRT deflection yokes for the Asian market.	Display Components 334 Littleton Rd. Westford, MA 01886 (617) 692-6000
IMPCO	E/M	To market the Oua-Seal process of impregnating and coating rare-earth magnets, a process that increases their strength.	IMPCO 335 Valley St. Providence, RI 02908 (401) 521-2490
Integrated Genetics	Amoco	To commercialize a test that detects the AIDS virus in blood samples.	Integrated Genetics 31 New York Ave. Framingham, MA 01701 (617) 875-1336
Online Computer Systems	Buchhandler Vereinigung	To develop German Books in Print on CO-ROM (compact disks with read-only memory). Plans call for a prototype disk in October 1987 and subscription disks in 1988.	Online Computer Systems 20251 Century Blvd. Germantown, MD 20874 (301) 428-3700

CONTRACTS AWARDED

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Apollo Computer 330 Billerica Rd. Chelmsford, MA 01824 (617) 256-6600	Cetia SA (subsidiary of France's Thomson CSF)	Not disclosed	To develop and market workstations based on Apollo computers.
Atlantic Research 5390 Cherokee Ave. Alexandria, VA 22312 (703) 642-4216	U.S. Navy	\$9 million	To produce MK-104 dual-thrust rocket motors for the Navy's Standard Missile.
Biatech Research Laboratories 1600 E. Gude Dr. Rockville, MD 20850 (301) 251-0800	National Institutes of Health	\$500,000	To develop tests that detect simian immunodeficiency virus, which is closely related to the AIDS virus.
Centel 8725 Higgins Rd. Chicago, IL 60631 (312) 399-5160	U.S. Postal Service	About \$100 million	To implement a computer-based system at about 225 postal centers to process change-of-address mail.
Ebasco Services 2 World Trade Center New York, NY 10048 (212) 839-2915	Tennessee Valley Authority	\$65 million	To complete construction projects to restore operation of Units 1, 2, and 3 of the Browns Ferry nuclear plant in Decatur, Alabama.
Eda 14-04 111th St. College Point, NY 11356 (718) 445-6000	U.S. Naval Air Systems Command	About \$25 million	To supply MK 105 magnetic minesweeping systems and associated ground-support equipment.
Electraspace Systems 8ax 83159 Richardson, TX 75083 (214) 470-2000	General Dynamics, Electric Boat Division	\$267,000	To manufacture four T53858/UR antenna calibrator-monitors for use on the 688 Class submarine.

■ MARKETWATCH ■

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Environmental Industrial Research Associates Metairie, LA 70001 (504) 831-3600	U.S. Environmental Protection Agency	\$1.1 million	To provide analytical services in support of the Superfund toxic-waste cleanup program.
Ford Aerospace 1235 Jefferson Davis Hwy. Arlington, VA 22202 (703) 685-5555	U.S. Air Force	\$15.2 million	To operate and maintain the Air Force's Electronic Warfare Range Complex in the Philippines.
Intermagnetics General Box 566 Guilderland, NY 12084 (518) 456-5456	U.S. Department of Energy	Three contracts, \$500,000 each	To improve the performance of niobium-titanium superconductors; develop niobium-tin superconductors with improved properties; and develop a continuous process to combine superconductors with high-purity aluminum.
Julie Box 141 Billerica, MA 01821 (617) 667-1958	Food and Drug Administration	Not disclosed	To conduct electrostatic-discharge awareness workshops for FDA investigators.
Lockheed Missiles & Space Co. Box 3504 Sunnyvale, CA 9408B (408) 742-6688	NASA	About \$140 million	To automate the design and development of software for the U.S. space station.
McDonnell Douglas Box 516 St. Louis, MO 63166 (314) 232-0232	Hughes Aircraft	\$300 million	To launch two satellites for a British broadcasting company beginning in 1989, in what will be the first commercial use of the Hughes Delta rocket.
Medar 38700 Grand River Ave. Farmington Hills, MI 48018 (313) 477-7269	General Dynamics	About \$1 million	To manufacture subassemblies for tanks as part of the XK1 Korean tank program.
Ribi ImmunoChem Research Box 1409 Hamilton, MT 59840 (406) 363-6214	National Institute of Allergy and Infectious Diseases	\$49,000	To conduct preclinical research on vaccine-delivery systems using liposomes.
Rockwell International, North American Aircraft Operations Los Angeles, CA 90009 (213) 414-1092	U.S. Air Force	About \$155 million	Research and development to modify the C-130 aircraft into an AC-130U aircraft.
Singer Link Flight Simulation Div Binghamton, NY 13902 (607) 772-3127	U.S. Airforce	\$19.9 million	To modify 10 simulators used in the Military Airlift Command's C-130 aircrew training system.
Spire Patriots Park Bedford, MA 01730 (617) 275-6000	Army Materials Technology Laboratory	\$3.2 million	To develop advanced baffle materials through analysis, space-environment experiments, and optical testing.
Spire Patriots Park Bedford, MA 01730 (617) 275-6000	Wright-Patterson Air Force Base	\$53,000	To investigate temperature-stable, low-shock-loss metallization for space solar cells.
Telesatf 5959 Cornerstone Court West San Diego, CA 92121 (619) 457-2700	Institute for Defense Analyses (IDA)	Not disclosed	To develop courses to retrain the Defense Logistics Agency's Cobol development group in the Ada computer language.
TRW 2751 Prosperity Ave. Fairfax, VA 22031 (703) B76-4137	U.S. Air Force	\$3.1 million	To develop Ramcad prototype software, which will reduce the costs of acquiring and supporting military equipment. TRW will work with the Virginia Polytechnic Institute of Virginia.

MERGERS

COMPANY	BUSINESS	COMPANY	BUSINESS	NEW NAME
3Com 3165 Kifer Rd. Santa Clara, CA 95051 (415) 562-6400	Computer-network products	Bridge Communications 2081 Stierlin Rd. Mountain View, CA 94043 (415) 969-4400	Computer-network products	Bridge becomes a wholly owned subsidiary of 3Com but retains its name.
Lexican 2400 E. Commercial Blvd. Fort Lauderdale, FL 33308 (305) 772-7221	Holding company	Scope 1860 Michael Faraday Dr. Reston, VA 22090 (703) 471-5600	Electronics	Scope becomes a wholly owned subsidiary of Lexican but retains its name.

ACQUISITIONS

BUYER	BUSINESS	COMPANY ACQUIRED	BUSINESS	AMOUNT
Allied Research Associates Box 1000 Severna Park, MD 21146 (301) 269-5404	Holding company	Bornes & Reinecke 2375 Estes Ave. Elk Grove Village, IL 60007 (312) 640-7200	Heavy-weapons developer	\$4 million
Bell Atlantic 1600 Market St. Philadelphia, PA 19103 (215) 963-6000	Telecommunications	National Funding 3200 Park Center Dr. Casta Mesa, CA 92626 (714) 751-0991	Medical and commercial equipment leasing	Not disclosed
California Micro Devices 215 Topaz Milpitas, CA 95035 (408) 263-3214	Semiconductors	GTE Microcircuits Div. 2000 West 14th St. Tempe, AZ 85281 (602) 968-4431	Semiconductors	\$14.5 million
Dataquest 1290 Ridder Park Drive San Jose, CA 95131 (408) 971-9000	High-technology market analysis	Intelligent Electronics 15 Rue Buffon 75005 Paris, France 011 331-45354383	Research on personal computers in Europe	Not disclosed
Elographics 105 Randolph Rd. Oak Ridge, TN 37830 (615) 482-4100	Touch screens	Kennedy Technology 4830 View Ridge Ave. San Diego, CA 92123 (619) 541-7121	Touch screens	Not disclosed
Microsoft 10700 Northup Way Bellevue, WA 98004 (206) 828-8080	Software	Forethought 250 Sobrante Way Sunnyvale, CA 94086 (408) 737-1909	Software	\$14 million
Polaroid 545 Technology Square Cambridge, MA 02139 (617) 577-2000	Photographic products	Media Duplication Services 545 Technology Square Cambridge, MA 02139 (617) 577-2000	Software duplication	Not disclosed
ThumbScan 2 Mid-American Plaza Oakbrook Terrace, IL 60181 (312) 954-2336	User-authentication systems	Gordian Systems 3512 West Bayshore Rd. Palo Alto, CA 94303 (415) 494-8414	Hand-held user-authentication systems	Not disclosed
Wabash Datatech 221 E. Main St. Huntley, IL 60142 (312) 669-5181	Magnetic-media manufacturing	Designed Magnetics 140 Blue Ravine Folsom, CA 95630 (916) 351-1191	Magnetic-media coating application	Not disclosed
Warren, Garham & Lamant 1 Penn Plaza New York, NY 10119 (212) 971-5000	Business, accounting, and legal publishing	CPAid 1061 Fraternity Circle Kent, OH 44240 (216) 678-9015	Tox-preparation and accounting software	Not disclosed

THE HIGH TECHNOLOGY BUSINESS LEADING 100

Company (symbol)	Price increase last month (%)	Closing price (\$)	200-day price vs. industry average (%)	Earnings per share				P/E ratio	Debt/equity ratio	Latest 12 months' revenue (in millions)
				Last quarter (\$)	Change from 1 year ago	Latest dividend (\$)				
AEROSPACE										
Longly (LCOR)	53.3	11.50	121	0.14	-22.2	0.45	20.5	0	10.7	
Rohr Industries (RHR)	22.8	37.00	108	0.16	-75.4	0	20.4	0.04	619.2	
Martin Marietta (ML)	14.9	54.00	117	1.31	31.0	1.10	13.7	0.27	4,953.8	
OEA (OEA)	14.4	27.75	104	0.42	0	0	17.2	0	41.5	
ARX (ARX)	13.5	11.63	114	0.26	18.2	0	13.4	0.84	56.4	
Singer (SMF)	12.7	50.13	101	-0.90	-100.0	0.40	24.7	0.53	1,800.8	
Hexcel (HXL)	10.9	55.88	119	0.75	23.0	0.60	23.1	0.87	319.7	
Sequa (SQAA)	8.1	83.50	NC	1.16	110.9	.60	4.1	0.43	438.3	
TransTechnol (TT)	8.0	28.50	111	0.31	158.3	.80	11.5	0.72	212.8	
Boeing (BA)	7.6	51.50	84	0.75	-31.2	1.40	13.7	0.05	16,028.0	
CHEMICALS										
Georgia Gulf (GGLF)	32.0	59.38	NC	1.25	123.2	0	18.3	1.07	620.1	
Beker Ind. (BKI)	31.6	0.50	92	-1.14	NE	0	NE	1.56	150.9	
Genex (GNEX)	24.8	1.56	48	-0.13	NE	0	NE	0.07	2.7	
Martin Lawrence (MLLE)	24.1	8.38	165	0.14	133.3	0	25.4	0.12	15.5	
Publicker Ind. (PUL)	22.9	3.38	75	-0.08	NE	0	NE	1.95	12.5	
Betz Labs (BETZ)	19.7	57.00	103	0.64	10.3	1.52	24.7	0	359.3	
Vista Chem. (VC)	17.3	41.50	NC	0.83	93.0	0.05	17.7	3.56	582.2	
Ausimont (AUS)	16.5	23.75	78	0.49	16.7	0.32	14.0	0.25	702.2	
Nalco Chem. (NLC)	12.7	42.25	117	0.50	25.0	1.20	23.6	0.07	767.8	
Dow Chem. (DOW)	11.6	96.13	118	1.64	37.8	2.20	20.5	0.66	11,957.0	
COMMUNICATIONS										
Century Tel. (CTL)	30.4	25.75	136	0.38	5.6	0.86	17.1	1.51	147.9	
Telephone Data (TDS)	23.5	33.50	151	0.25	13.6	0.44	22.8	2.01	162.2	
SouthernNet (SOUT)	18.4	22.50	133	0.16	0	0	NE	.27	174.1	
Acton (ATN)	17.6	18.38	204	3.65	NE	.00	NE	2.18	25.8	
Pac Telesis (PAC)	17.3	30.50	94	.57	-13.6	1.64	12.4	.71	8,975.9	
Alltel (AT)	15.3	31.00	86	.66	11.9	1.36	17.6	1.21	720.2	
Elctel (ECTL)	15.2	19.00	NC	.14	7.7	.00	37.3	.00	13.2	
Contel (CTC)	14.5	37.50	102	.61	-17.6	2.00	12.6	1.28	3,070.1	
Millicom (MILL)	14.5	19.75	151	.06	-97.6	.00	2.6	.00	110.7	
United Telcom (UT)	13.1	32.38	95	-1.20	-100.0	1.92	NE	1.56	2,273.8	
COMPUTERS										
Franklin Computer (FDOS)	70.2	7.88	119	0.23	NE	0	NE	0.47	23.9	
Comp. Identics (CIDN)	36.2	1.88	49	-0.15	NE	0	NE	0	11.1	
Perceptrronics (PERC)	27.2	7.63	68	0.15	114.3	0	NE	0.51	46.0	
EMC (EMCS)	27.0	36.50	146	0.43	34.4	0	26.6	0.10	88.5	
Machine Vision (MVIC)	26.3	2.69	226	-0.07	NE	0	NE	0.61	2.1	
Sci. Micro. (SMSI)	26.1	7.25	88	0.10	25.0	0	24.2	0	88.9	
LTX (LTX)	25.9	18.88	147	-0.14	NE	0	NE	0.67	110.7	
Griffin Tech. (GRIF)	24.2	5.75	112	-0.02	NE	0	24.0	0.94	10.7	
Zentec (ZENT)	22.3	5.81	96	0.03	-70.0	0	16.1	0	32.7	
C COR Electronics (CCBL)	21.6	11.25	110	0.12	NE	0	31.3	0.03	26.3	
DRUG MANUFACTURERS										
IGI (IGEN)	88.3	7.06	275	0.03	200.0	0	88.3	0.64	18.0	
Cornington Labs (CARN)	39.8	34.25	84	-0.17	NE	0	NE	.00	3.8	
Viratek (VIRA)	31.3	21.00	18	-0.34	NE	0	NE	0	7.4	
Nature's Sunshine (AMTC)	16.7	8.75	159	0.26	116.7	0	12.0	0.08	34.6	
Molecular Biosyst. (MOBI)	13.2	10.75	167	0	NE	0	NM	0.06	2.8	
K V Phorm. (KVPH)	12.5	18.00	89	0.03	-57.1	0	NM	1.59	23.4	
Amgen (AMGN)	12.3	32.00	98	0.02	-33.3	0	NM	0.08	35.9	
Merck & Co. (MRK)	11.5	204.00	126	1.72	41.0	3.20	35.9	0.07	4,563.2	
Amer. Home Prod. (AHP)	11.1	95.00	81	1.33	10.8	3.34	17.4	0	4,980.0	
Bolar Pharm. (BLR)	7.8	27.50	89	0.23	35.3	0.05	24.1	0	61.9	

■ MARKET WATCH ■

The following are the 10 companies in each of 10 industries that had the highest stock gain over the previous month. (Figures as of 8/18/87)

NE = Negative earnings NC = Not calculable NM = No meaningful figure

Company (symbol)	Price increase last month (%)	Closing price (\$)	200-day price vs. industry average (%)	Earnings per share			Latest dividend (\$)	P/E ratio	Debt/equity ratio	Latest 12 months' revenue (in millions)
				Last quarter (\$)	Change from 1 year ago	Lates dividend (\$)				
ELECTRONICS										
Hole Systems (HSYS)	77.8	0.16	57	-0.11	NE	0	NE	0	2.8	
Rond Info. Syst. (RINSE)	63.6	1.44	198	-0.33	-100.0	0	NE	1.64	7.5	
Video Display (VIDE)	48.3	22.25	211	0.16	23.1	0	34.8	1.29	24.7	
SBE (S8EL)	43.2	0.63	86	0.01	NC	0	15.6	0	7.6	
Genex (GNTX)	41.2	6.00	120	0.06	20.0	0	28.6	0.05	14.5	
Telemation (TLMT)	36.6	3.25	50	-0.03	-100.0	0	NE	0.44	11.0	
Pico Products (PPI)	35.5	7.63	300	0.05	NE	0	NE	0.12	29.6	
TDK (TDK)	28.3	70.75	95	-0.53	-100.0	0.51	89.6	0.12	2,384.4	
Sany (SNE)	26.7	35.00	108	0.53	15.2	0.22	29.7	0.24	8,563.4	
TeleSciences (TSC)	25.0	2.50	31	-0.78	NE	0	NE	0	20.2	
HEALTH										
Meridian Diag. (KIT5)	29.6	4.38	38	0.02	-71.4	0	33.7	0.04	5.3	
Fonar (FONR)	28.9	5.00	56	0.03	-25.0	0	62.5	41.00	40.9	
OCG Technology (OCGT)	25.0	2.50	223	-0.04	NE	0	NE	0	0.1	
Daman (DMN)	22.4	24.63	133	0.24	NE	0.20	NM	0.51	167.9	
Oncongene Sci. (ONCS)	19.6	5.38	96	0.01	0	0	NM	0	4.7	
Collagen (CGEN)	17.9	11.50	83	0.10	-33.3	0	50.0	0.01	22.3	
Vicon Fiber (VFOX)	16.9	2.63	109	-0.06	NC	0	NE	0.06	11.3	
Acme United (ACU)	16.3	8.00	78	0.07	40.0	0	NE	0.34	35.3	
Life Tech. (LTK)	15.0	17.25	142	0.16	45.5	0	50.7	0.16	101.9	
Marquest Med. (MMPI)	14.8	12.63	125	0.20	150.0	0.07	NE	0.98	39.6	
METALS FABRICATION										
Material Sci. (MSC)	24.2	25.63	103	0.25	-21.9	0	21.7	0.74	136.4	
Eastern Co. (EML)	15.8	34.75	137	0.69	91.7	1.00	15.2	0.20	78.9	
Metex (MTX)	12.6	12.25	81	0.20	-37.5	0	13.2	0.21	30.0	
Zero (ZRO)	12.2	19.50	103	0.24	14.3	0.36	20.3	0.12	127.1	
Trinity Ind. (TRN)	11.6	31.25	144	0.07	-12.5	0.50	91.9	1.28	501.6	
Intl. Aluminum (IAL)	11.2	22.38	99	0.25	4.2	0.72	15.3	0.19	172.7	
Wyman-Gordon (WYMN)	11.1	20.00	84	0.18	-5.3	0.80	NE	0.07	340.5	
Temtex Ind. (TMTX)	10.5	5.25	72	0.10	NE	0	NE	0.77	30.2	
Coml. Shearing (CSHR)	8.9	16.88	101	0.16	-15.8	0.56	19.9	0.68	307.2	
Coml. Metals (CMC)	8.6	22.00	112	0.45	-8.2	0.32	17.3	0.26	869.2	
SCIENTIFIC & ELECTRONIC INSTRUMENTS										
Kevex (KEVX)	27.3	7.00	112	0.04	NC	0	NE	0.01	33.5	
Lasermetrics (LSRM)	26.8	1.75	207	-0.01	-100.0	0	NE	0.82	4.2	
Keweenaw Sci. (KEQU)	20.0	10.50	71	-1.88	NE	0	NE	0.48	59.5	
Arizona Inst. (AZIC)	16.2	6.25	115	0.07	133.3	0	22.3	0.20	6.3	
Birnbaum Inst. (BRIK)	16.2	9.88	NC	0.22	37.5	0	14.7	0	57.9	
Environ. Tectonics (ENVT)	15.0	5.75	97	0.03	-25.0	0	95.8	0.18	12.5	
Finnigan (FNNG)	13.2	19.25	119	0.16	300.0	0	NE	0.36	92.1	
Teradyne (TER)	12.8	31.88	142	-0.11	-100.0	0	NE	0.05	314.7	
Instron (ISN)	12.5	15.75	89	0.14	-22.2	0.12	23.9	0.23	88.9	
KLA Inst. (KLAC)	12.2	23.00	115	0.01	-92.9	0	54.8	0	88.2	
SOFTWARE AND DATA PROCESSING										
Decision Sys. (OCSN)	50.0	3.75	341	-0.20	-100.0	0	NE	1.00	24.2	
Info Science (INSI)	50.0	0.75	27	-0.67	NE	0	NE	0.07	14.8	
CMX (CXC)	40.0	1.75	106	0.02	NC	0	17.5	0.71	12.1	
Avant Garde (AVGA)	39.9	4.38	66	2.30	NE	0	2.6	0	17.4	
Natl. Ooto (NDTA)	34.4	31.75	90	0.31	-54.4	0.44	26.5	0.04	158.8	
Tenera (TLPZZ)	30.4	7.50	97	0.27	NE	0	16.3	0	38.8	
Oyatron (DYTR)	27.6	7.50	79	0.19	NE	0	10.0	0.12	34.9	
SCS Compute (SCMT)	24.1	9.00	104	1.49	964.3	0	15.0	0.83	18.0	
Quality Syst. (QSII)	23.5	2.63	89	0.01	-66.7	0	21.9	0	9.6	
Altai (ALTI)	22.2	4.13	64	0.02	-66.7	0	34.4	0.29	8.1	

RESEARCH REPORTS

STUDY BY	TITLE	FORECAST	PRICE
Business Communications 25 Van Zant St. Norwalk, CT 06855 (203) 853-4266	Plastics for Large Automotive Parts (# P-104)	Growth rate will be 10% per year, with 792 million pounds used annually by 1991. From 1991 to 1996, 7% annual growth will push total to 1,142 billion pounds.	\$2,450
ElectroniCast 2121 S. El Camino Real San Mateo, CA 94403 (415) 572-1800	Microwave Monolithic Integrated Circuit Forecast	Market will grow to \$160 million by 1991, and to \$2.3 billion by 1997.	\$18,000
Frost & Sullivan 106 Fulton St. New York, NY 10038 (212) 233-1080	U.S. Market for Local-Area Networks in Offices (# A1666)	Unit shipments of general-purpose local-area networks will nearly double each year, from 354,100 in 1986 to 9.8 million in 1991.	\$1,950
Input 1943 Landings Dr. Mountain View, CA 94043 (415) 960-3990	Future Database-Management-Systems Markets, 1987-1992	Annual growth rate of 22% over the next five years.	\$1,650
IRD 21 Locust Ave. New Canaan, CT 06840 (203) 966-2525	Worldwide Laser Markets (# 742)	Specialization, mergers, acquisitions, and bankruptcies will result in large electronics companies dominating the laser industry.	\$1,850
Market Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000	Drug-Abuse Testing Markets (# A214)	The market for screening tests, now at \$80 million, will reach \$236 million by 1993, with annual growth of 16.7%. Sale of testing instruments will expand 17% through 1993.	\$995
Market Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000	The Status of Biotechnology (# A231)	Reviews the impact of biotechnology on investments, the science of biotechnology, and new trends; forecasts growth in specific markets.	\$995
Market Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000	Trends and Transitions in Health-Care Financing (# A183)	Gives three scenarios through 1993—continuation of present policies, a weakened economy, and a stronger economy. Covers government involvement in health care.	\$995
Strategic Analysis Fairlane Rd. Reading, PA 19606 (215) 779-9080	Catalysts for Environmental Control: Stationary Sources	The market will exceed \$800 million in western Europe by 1990.	\$8,000
Strategic Analysis Fairlane Rd. Reading, PA 19606 (215) 779-9080	Strategic Opportunities in Advanced Materials	U.S. consumption of advanced polymer composite shapes will increase annually by 10% and reach \$3.4 billion by 1996.	\$250,000 for consultants, \$20,000 for subscribers
Strategic Analysis Fairlane Rd. Reading, PA 19606 (215) 779-9080	Strategic Opportunities in Superconductors	The market for superconductor materials and end-use products will grow from current \$290 million to \$1.8 billion by 2005.	\$20,000
Theta Theta Building Middlefield, CT 06455 (203) 349-1054	Electrotherapeutic Device Market (# 721)	Examines market for electrotherapeutic devices (muscle stimulators, ultrasound) and diathermy (using electric current to generate heat in tissue).	\$495
Theta Theta Building Middlefield, CT 06455 (203) 349-1054	U.S. Market for In-Vivo Imaging Agents (# 740)	Market trends for in-vivo imaging agents in diagnosing specific cancers and cardiovascular diseases; profiles 12 major competitors for this market.	\$795

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B. Radio, cassette tape or buzzer—three ways to start a new day are all at your fingertips with Sharp's new AM/FM digital clock radio (model no. FXC100) with cassette player and auto stop. Large, easy to read green LED display tells you the time from virtually any angle, while battery back up ensures uninterrupted operation. Best of all, the unit comes with a 59-minute sleep timer for those who just can't give up the mattress! $9\frac{1}{16}$ "W" \times $4\frac{1}{8}$ "H \times $4\frac{3}{4}$ "D.

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B.

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C. Make tracks but do so discreetly with Rally's super compact radar detector (model no. XK500). About the width of your key chain, this radar detector comes standard with features normally found in much higher end units. The heart of the unit is the dual conversion X & K bands superheterodyne technology, which gives you complete cover from both of the frequencies police transmit on to snare speeders. Other features include LED signal strength meter, city/highway switch, variable volume control and dash visor mounting bracket. All at a s-low, s-low price!

$3\frac{1}{4}$ "W \times $\frac{7}{8}$ "H \times $4\frac{3}{4}$ "D.

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J.H. Sharff
J.H. Sharff
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The Answer You Wanted to Hear

A. Sharp's new line of combination telephone and answering systems (model no. FP700) will make it seem like there's a receptionist in your home. Advanced features include IC recording chip, which makes for improved voice reproduction and eliminates the need for a second microcassette tape, thus clearing out space for more convenience features. And the list is long, including local message memo, on-line conversation record, call screening and select call. Sharp has designed this advanced machine for ease of operation, with beeperless remote, 12 auto dial memory and pulse/tone switchable. Available in blue/white or black.

$6\frac{1}{16}$ "W \times $3\frac{15}{16}$ "H \times $8\frac{1}{16}$ "D.



CALL TOLL FREE
1-800-962-2962

Complete Entertainment Center

A Sound Viewing Experience

A. Sharp's new 140-channel cable capable 20-inch Super VHS compatible monitor/TV (model no. 20MV97) set is absolutely state of the art. Flat, square, tinted picture tube is capable of up to 400 lines of horizontal resolution when used with Super VHS. By contrast, regular TV broadcasts at 320 lines while the average VCR tunes in at a mere 270 lines. You'll be wondering how such exhilarating audio and clear, bright images can come out of such a compact unit. The answer: a built-in MTS (multi-channel TV sound) stereo decoder and two-way two-speaker stereo. But that's not all you get for this great price, because the 26-function solar powered infrared remote needs no batteries. And, on screen display indicates channel, time of day, volume and minutes remaining on sleep timer. Includes A/V jacks for easy computer hookup. $23\frac{1}{32}$ "W $\times 22\frac{43}{64}$ "H $\times 22\frac{1}{4}$ "D. RT004 Retail 799.00

Telshop Price 549.00 (20.95)
Save 250.00



A.

Well-Done Rack of Sound

C. Sharp has delivered the best affordable sound system (model no. Z1000-DX) on the market today. The heart of the system is a **monster receiver** that puts out 120-watt minimum per channel into 8 ohms from 40 Hz to 20,000 Hz with no more than 0.5% total harmonic distortion. The receiver includes 7-band graphic equalizer *and* 7-band spectrum analyzer to permit precise calibration of the sound to the listener's sonic tastes and to individual room acoustics. A **compact disc player** with 20 random access programming and 3-beam laser pick-up produces crisp, clear sound, while a **digital synthesized tuner** with 14 station presets and auto scan finds the station for you and then locks it in. Rounding out the system are a semi-automatic belt driven **turntable** and dual **cassette deck** with high speed dubbing continuous playback and DOLBY noise reduction. And topping it all off are a **pair of speakers** that will surely bring music to your ears. A specially developed three-way system, each speaker contains a 5-inch midrange and dome type tweeter, anchored by a **10-inch down firing super woofer** that disperses rich, powerful bass evenly to all parts of the listening room. A package hard to beat at twice the price!

Rack $20\frac{1}{8}$ "W $\times 40\frac{5}{8}$ "H $\times 16\frac{1}{16}$ "D. Speakers $13\frac{1}{16}$ "W $\times 41\frac{1}{8}$ H $\times 13\frac{1}{16}$ D.

RT006 Retail 1349.95 Telshop Price 995.00 (\$75 truck) Save 354.95



C.



Picture Perfect Video Cassette Recorder

E. Do you often wish you could view several channels at once? Your wish has been granted by Sharp's new 110 channel cable ready digital special effects two-head VCR (model no. VCD800U) with its 9 picture on screen and channel search with picture in picture. VHS HQ circuitry with double comb filter ensures vivid, razor sharp picture. Standard equipment also includes TV strobe slow motion playback and still function for matchless slow motion and freeze frame; random access tuner for instant channel switching; 14-day, two-event programming; 35-function wireless remote and two-speed video search. And Sharp has included

some nice little extras: on screen timer programming display and blue screen noise elimination system. $17\frac{1}{2}$ "W $\times 4\frac{1}{2}$ "H $\times 13\frac{3}{4}$ D.

RT008 Retail 499.00
Telshop Price 399.00 (11.95)
Save 100.00



E.



A Little Travelin' Music

D. Compact-disk quality sound to go is now a reality with Sharp's new feather-like 12 pound totable unit (model no. WQCD30). But you're not limited to CDs only, because Sharp added twin cassette decks with continuous playback from tape one to tape two, as well as high speed dubbing. The side-to-side placement of the cassette decks has twin benefits. One, it allows for a much smaller unit and two, it reduces distortion when recording from one tape to another since all heads are located on one capstan. Rounding out a great sound package are a 3-band graphic equalizer and a super sensitive AM-FM stereo radio. This pleasure machine would make a superb gift to give—and to receive! 23 1/4" W x 5 5/8" H x 7 5/8" D.

RT007 Retail 419.95 Telshop price 249.95 (5.95)

Save 170.00

D.

User-Friendly Camcorder

F. Ease of operation and up-to-the-minute technology converge in Sharp's new miniature camcorder (model no. VLC73UA). Sharp wanted to design a camcorder that would be simple enough to be used with great results by novices, yet with enough professional quality options to meet the needs of video mavens. Mission accomplished. Most important, easy-to-use 1/2-inch VHS-C cassettes are fully compatible with VHS recorders once tape is placed in an adaptor included with the unit. Video sophisticates will warm to the high speed electronic shutter with 1/1000th second shutter speed, variable 8x power zoom lens, sound track mixing, HQ system quality plus CCD image sensors and full auto white balance, auto iris, auto date and auto power off. Neophytes will enjoy the automatic focus, which allows the



F.

user to simply aim and shoot. Everybody will relish the super-SHARP images. 5 lbs.

RT009 Retail 1599.00

Telshop price 1199.00 (5.95) Save 400.00

Performance Video on a Shoestring

B. You probably thought a performance-oriented VCR at a reasonable price was thoroughly impossible? It was—until Akai developed this new model (model no. VS-M910-UB), which, in critical ways, is identical to Akai's costliest units. DX4 four head double azimuth system with HQ circuitry provides highest quality reproduction and super-sharp analog special effects, and is programmable for six broadcasts over two weeks. Other standard features include VHS "HI-FI" with MTS stereo, 167 channel cable ready tuner; the world's first VHS quick start system with index and address search; super clear slow motion, still frame and frame

advance. And for those who like to see the results of their efforts, Akai designed this super sophisticated unit with on-screen programming. Now, setting the channel and timer's problem free! 15.2" W x 3.6" H x 14.3" D.

RT005 Retail 749.00

Telshop price 599.00 (11.95) Save 150.00



B.



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■ OFFICE PRODUCTS



Nefax-20 fax machine. Offers a programmable, four-megabit memory for unattended transmissions, one-touch dialing for 20 numbers, and resolutions of 100 or 200 lines/in. \$3,395. NEC America, Facsimile Div., 8 Old Sod Farm Rd., Melville, NY 11747. (800) 782-7329; in NY, (516) 753-7406. *Circle 1.*

CAP computer-aided publishing system. A workstation that captures images by video camera or digital scanner, integrates them with text on an 11 × 17-in. monitor, and prints the document on a laser printer. From \$50,000. Rise Technology Inc., 1 Kendall Square, Cambridge, MA 02139. (617) 491-6601. *Circle 2.*

DC-5055 plain-paper copier. Handles 50 copies/minute; provides zoom reduction and enlargement, automatic magnification and cassette selection, and four-way paper feed with a 50-sheet stack bypass. \$7,295. Mita Copystar America Inc., Box 813, Hasbrouck Heights, NJ 07604. (201) 288-6900. *Circle 3.*

Facsimile Pac PC-fax machine. This circuit board and software lets IBM PC/XT/AT and compatible computers communicate with digital facsimile machines. Features include automatic dialing and delayed transmission, storage and forwarding, and serial broadcasting. \$1,495. Dest Corp., 1201 Cadillac Court, Milpitas, CA 95035. (408) 946-7100. *Circle 4.*

LANlink local-area network. An updated version that lets network users share application software, hard-disk storage, and printers. Links Personal System/2, IBM PC/AT, and compatible systems. \$495. The Software Link Inc., 3577 Parkway Lane, Atlanta, GA 30092. (404) 448-5465. *Circle 5.*

Microsafe alarm system. Provides 24-hour protection for personal computers and

other equipment. Uses a light-supervised fiber-optic cable that snakes through openings in or brackets attached to equipment, plug-in circuit boards, software lock-boxes and other items; an alarm sounds if an item is removed. From \$201.50. Microsafe Products Co., Box 2393, Kirkland, WA 98083. (206) 881-6390. *Circle 6.*

PASS security system. The Photo Access Security System (PASS) acts as an electronic mug book. In about five minutes, the system creates a badge with a color photo, employee signature, and other data. This information goes into a database that can be accessed at all stations in the network. The software costs \$3,000; stations start at \$20,293. U.S. Imaging and Security Inc., 1300 Dexter Ave. N., Suite 350, Seattle, WA 98109. (206) 284-3390. *Circle 7.*

Proswitch line-exclusion switch. Lets people share a central-office/PBX line automatically. Compatible with all PBX/Key systems; works with modems, fax machines, and pay phones. From \$75. Protel Communications Inc., Box 31174, Tucson, AZ 85751. (602) 624-1934. *Circle 8.*

Targaplot color copier. Prints in color from personal computers equipped with the AT&T Truevision graphics adapter; resolution is 240 dots/in. From \$4,495. Seiko Instruments USA Inc., Graphic Devices & Systems Div., 1130 Ringwood Court, San Jose, CA 95131. (408) 943-9100. *Circle 9.*

Tartan XP90 scanner. Processes documents with both text and graphics; includes the XP90 optical-character-recognition page scanner and the company's REI PC AT system. From \$80,000. Recognition Equipment Inc., Box 660204, Dallas, TX 75266. (214) 579-6000. *Circle 10.*

Tokenstar 4012/4024 communications link. Sends data at one megabit/second over telephone wires without affecting phone conversations. \$1,995 for Model 4012, \$3,495 for Model 4024. Telegence Corp., 5655 Linder Canyon Rd., Suite 722, Westlake Village, CA 91326. (818) 707-3200. *Circle 11.*

Voicemail phone system. Answers calls, stores messages, and notifies people of messages. Works with a Centrex telephone-switching service. Centigram Corp., 4415 Fortran Ct., San Jose, CA 95134. (408) 942-3500. *Circle 12.*

■ COMPUTER HARDWARE

Bernoulli 5 $\frac{1}{4}$ -in. internal/external drives. Designed for IBM PCs and compatibles, these drives store 20 megabytes and allow removal of floppy disks. \$900 to \$2,499. Iomega Corp., 1821 West 4000 South, Roy, UT 84067. (801) 778-3170. *Circle 13.*

Bridge-File converter. Provides a two-way link between the IBM PC/XT/AT and the Personal System/2. A 3 $\frac{1}{2}$ -in. version stores 720 kilobytes and 1.44 megabytes on floppy disks; the 5 $\frac{1}{4}$ -in. model holds 360 kilobytes and 1.2 megabytes. \$325. Sysgen Inc., 556 Gibraltar Dr., Milpitas, CA 95035. (800) 821-2151; in CA, (408) 263-4411. *Circle 14.*

Bridge-Tape converter. Offers 42-megabyte tape storage to transfer data between IBM PCs and the Personal System/2; serves as a tape-backup unit for conventional storage media. \$795. Sysgen Inc., 556 Gibraltar Dr., Milpitas, CA 95035. (800) 821-2151; in CA, (408) 263-4411. *Circle 15.*

Coaxial Gateway board and software. Lets IBM PCs and Personal System/2 computers on a local-area network access as many as 40 mainframe sessions at the same time. \$1,100 for the board; \$850 for the software. CXI Inc., 1157 San Antonio Rd., Mountain View, CA 94043. (800) 225-7269; in CA, (415) 969-1999. *Circle 16.*

External DuraPak hard-disk subsystem. Links IBM PCs with the Personal System/2 Model 30 and provides 15 megabytes of storage. Has built-in power supply. \$1,595. Sysgen Inc., 556 Gibraltar Dr., Milpitas, CA 95035. (800) 821-2151; in CA, (408) 263-4411. *Circle 17.*

F68HC11FN single-chip computer. Includes a high-level language and operating system that allows interactive user programming with no additional support chips. \$37.25. New Micros Inc., 1601 Chalk Hill Rd., Suite A, Dallas, TX 75212. (800) 255-4664; in TX, (214) 339-2204. *Circle 18.*

IMSU integrated mass-storage unit. A storage option for the company's Network Probe data-communication diagnostic instruments. The IMSU has a 3 $\frac{1}{2}$ -in. disk drive and writes all data to both RAM and disk in real time. With the IMSU, Network Probes cost \$3,790 to \$5,790. Network Communications Corp., 10120 W. 76th St., Eden Prairie, MN 55344. (612) 944-8559. *Circle 19.*

MacTilt SE security system. Protects the internal hard drive on Macintosh SEs equipped with the MacTilt stand. \$129.95 with the MacTilt SE; \$49.95 alone. Ergotron Inc., 1621 E. 79th St., Minneapolis, MN 55420. (800) 328-9839; in MN, (612) 854-9116. Circle 20.

MB832000, MB832001, and MB83-4100 memories. Three high-density masked ROM devices in byte-wide and word-wide configurations. The first two models hold two megabits each; the third stores four megabits. Fujitsu Microelectronics Inc., 3320 Scott Blvd., Santa Clara, CA 95054. (408) 562-1000. Circle 21.

Microline 393 24-pin printer. This printer offers four printing speeds, the fastest 450 characters/second. \$1,399 for black printing, \$1,499 for color. Okidata, 532 Fellowship Rd., Mount Laurel, NJ 08054. (609) 235-2600. Circle 22.

Mira 3480 cleaning cartridge. Designed to improve the performance of 3480 and compatible magnetic-media drives. Cleans drive heads in 10 to 15 seconds without solvents; each cartridge good for about 500 cleaning cycles. \$14.99. Wabash Datatech Inc., 221 E. Main St., Huntley, IL 60142. (800) 323-9868; in IL, (312) 669-5181. Circle 23.

PADC-DAC-8 converter expansion board. Performs analog-to-digital and digital-to-analog conversion for the P68000 MicroLab, a programming kit for the 68000 microprocessor. The board also works with any device with two 8-bit parallel ports. \$295. Quasitronics Inc., 211 Vandale Dr., Houston, PA 15342. (800) 254-4192; in PA, (800) 254-4192. Circle 24.

Print buffer. Mounts inside an Epson printer to transfer data to the printer at computer speed; allows resumption of computer operations while the printer runs at its own pace. \$109 to \$157. Image Technology Inc., 8150 S. Akron St., Suite 405, Englewood, CO 80112. (303) 799-6433. Circle 25.

TurboLaser/EL laser printer. Adapts to handle word-processing, desktop-publishing, CAD/CAM, and business-graphics applications. Prints eight pages/minute with 300-dot/in. resolution. \$1,995. AST Research Inc., 2121 Alton Ave., Irvine, CA 92714. (714) 863-1333. Circle 26.

COMPUTER SOFTWARE

BPCS decision-support system. For those who use IBM System/38 and System/36 computers, this software performs business modeling, retrieves information, and provides electronic mail. \$15,000 to \$20,000. System Software Associates Inc., 200 W. Madison, Suite 2850, Chicago, IL 60606. (312) 641-2900. Circle 27.

Capture expense-management package. Manages corporate travel and entertainment expenses. AMR Corp., Box 619630, MD 1387, Dallas/Fort Worth Airport, Dallas, TX 75261. (817) 540-6709. Circle 28.

Complete Answering Machine message handler. This processor board for Microsoft MS-DOS-based personal computers provides personal voice mail, advanced message handling, and basic telephone-answering-machine functions. \$349. The Complete PC, 521 Cottonwood Dr., Milpitas, CA 95805. (408) 434-0145. Circle 29.

Computerized parcel system. Runs on any IBM-compatible computer to produce labels and forms for UPS mailing; also tracks unpaid bills or undelivered packages. \$295. Harvey Software, Box 06596, Fort Myers, FL 33906. (800) 231-0296; in FL, (800) 330-8600. Circle 30.

FoxBase database manager. Combines the interactive capabilities of dBase with a high-speed compiler. \$395 to \$595. Fox Software, 27493 Holiday Lane, Perrysburg, OH 43551. (419) 874-0162. Circle 31.

Hypercard organizer. Helps those who use Macintosh computers organize various types of information, from phone lists to research. \$49. Apple Computer, 20525 Mariani Ave., Cupertino, CA 95014. (408) 996-1010. Circle 32.

IQ Analysis insurance service. A computer service listing insurance companies that offer term life-insurance policies at low cost; rates the five best policies based on age, sex, amount of coverage. InsuranceQuote Services, 3200 N. Dobson Rd., Bldg. C, Chandler, AZ 85224. (800) 972-1104; in AZ, (602) 345-7241. Circle 33.

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Supportcall customer-service system. Automates software customer-service phone systems; fields calls 24 hours a day from any touch-tone phone. Call (919) 667-8749 to hear a typical response. Wilkes Technologies, 910 Main St., North Wilkesboro, NC 28659. (919) 667-6629. Circle 36.

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calendars, running on the company's Series 500 minicomputers. \$2,000. NBI Inc., Box 9001, Boulder, CO 80301. (303) 938-2583. Circle 37.

TIP/PC computer-aided software-engineering tool. This custom version of Index Technology's Excalibur analysis and design software supplements Technology Information Product's mainframes. Supports development, planning and analysis. \$9,200; \$800 for Excalibur owners. Technology Information Products Corp., 12 New England Executive Park, Burlington, MA 01803. (617) 273-5818. Circle 38.

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Vac Elut SPS-24 sample processor. Processes as many as 24 silica extraction columns at once. The product's glass construction allows sample monitoring. \$895. Analytichem International Inc., 24201 Frampton Ave., Harbor City, CA 90710. (213) 539-6490. Circle 39.

1900 network file server. Lets NEC 1500 workstations share disk storage, printers, plotters, and scanners. The product includes a 32-bit system bus; four megabytes of main memory; and a 1.2-megabyte, 5 1/4-in. floppy-disk drive. From \$54,000. NEC Information Systems Inc., 1414 Massachusetts Ave., Boxborough, MA 01719. (617) 264-8000. Circle 40.

26MT-A and 36MT-A bridge-rectifier modules. Handle 25 and 35 amps, respectively, of average dc output with repetitive peak reverse-voltages from 50 to 1200 volts. \$9.73 to \$11.40. International Rectifier, 233 Kansas St., El Segundo, CA 90245. (213) 640-6517. Circle 41.

Ada compiler. For computers operating in the Ada computer language, which is used by the Department of Defense and other government agencies. \$20,900, with a monthly licensing fee of \$800. Tandem Computers, 19333 Valco Pkwy., Cupertino, CA 95014. (408) 725-6000. Circle 42.

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14	44	74	104	134	164	194	224	254	284	314	344	374
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22	52	62	112	142	172	202	232	262	292	322	352	382
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24	54	64	114	144	174	204	234	264	294	324	354	384
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26	56	66	116	146	176	206	236	266	296	326	356	386
27	57	67	117	147	177	207	237	267	297	327	357	387
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This computer-aided-design service converts a CMOS/Bulk graphics database into an equivalent CMOS/silicon-on-insulator database. Price varies. Westinghouse, Advanced Technical Division, Mail Stop 11-12, Camp Meade Rd., Baltimore, MD 21203. (301) 765-4339. *Circle 46.*

ColorWriter 400 electrostatic plotter. A single-pass system with 400-dot/in. resolution. Makes 36-in. color plots. \$79,000 to \$114,000. Synergy Computer Graphics Corp., 260 Santa Ana Court, Sunnyvale, CA 94086. (408) 749-8600. *Circle 47.*

Computer-aided-engineering software. Three packages that analyze power supplies and other designs. A transformer library of core materials costs \$7,500; a power-discrete library is \$2,500; a power-integrated-circuit library costs \$5,000. Daisy Systems Corp., 700 Middlefield Rd., Mountain View, CA 94039. (415) 960-6497. *Circle 48.*

CNC-1000 calibration network controller. Provides high-speed network control and disk space for archives. Handles scheduling and traceability reporting. From \$65,000. Diversified Data Systems Inc., 2601 N. Fairview Ave., Tucson, AZ 85705. (602) 792-3250. *Circle 49.*

CPU-XTX wastewater-treatment system. Removes heavy metals from waste water flowing as fast as 300,000 gallons per day. Takes up less than 400 square feet. From \$80,000. Environmental Technology Inc., 223 Hickman Dr., Sanford, FL 32771. (305) 321-7910. *Circle 50.*

CT-10 robotic wafer handler. Transports wafers of any size within a two-foot diameter. The 6×4×3-in. unit operates in a vacuum system. \$3,000. Advanced Control Engi-

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PADC-DAC-8 converter expansion board. Performs analog-to-digital and digital-to-analog conversion for the P68000 MicroLab, a programming kit for the 68000 microprocessor. The board also works with any device with two 8-bit parallel ports. \$295. Quasitronics Inc., 211 Vandale Dr., Houston, PA 15342. (800) 254-4192; in PA, (800) 254-4192. *Circle 24*.

Print buffer. Mounts inside an Epson printer to transfer data to the printer at computer speed; allows resumption of computer operations while the printer runs at its own pace. \$109 to \$157. Image Technology Inc., 8150 S. Akron St., Suite 405, Englewood, CO 80112. (303) 799-6433. *Circle 25*.

TurboLaser/EL laser printer. Adapts to handle word-processing, desktop-publishing, CAD/CAM, and business-graphics applications. Prints eight pages/minute with 300-dot/in. resolution. \$1,995. AST Research Inc., 2121 Alton Ave., Irvine, CA 92714. (714) 863-1333. *Circle 26*.

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BPCS decision-support system. For those who use IBM System/38 and System/36 computers, this software performs business modeling, retrieves information, and provides electronic mail. \$15,000 to \$20,000. System Software Associates Inc., 200 W. Madison, Suite 2850, Chicago, IL 60606. (312) 641-2900. *Circle 27*.

43551. (419) 874-0162. *Circle 31*.

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AD9610 operational amplifier. A wide-band, transimpedance amplifier that combines high-speed dynamic performance and pulse fidelity. \$49.88 to \$79. Analog Devices Inc., 1 Technology Way, Norwood, MA 02062. (617) 329-4700. *Circle 43.*

Airlink satellite antenna. This phased-array antenna provides telephone service and low-speed data transmission via communications satellites for airplane pilots, crew, and passengers. Available in 1988. Ball Corp., Aerospace Systems Div., Box 1062, Boulder, CO 80306. (303) 939-6548. *Circle 44.*

Auto-operator software. To increase a computer's processing speed, this program automates computer operations, automatically identifying and correcting problems for CICS and IMS systems. Complements IBM's NetView Release 2 software. From \$30,000 for IMS, from \$15,000 for CICS. Boole & Babbage, 510 Oakmead Parkway, Sunnyvale, CA 94086. (408) 735-9550. *Circle 45.*

Bitech database converter. To help design radiation-hardened integrated circuits, this computer-aided-design service converts a CMOS/Bulk graphics database into an equivalent CMOS/silicon-on-insulator database. Price varies. Westinghouse, Advanced Technical Division, Mail Stop 11-12, Camp Meade Rd., Baltimore, MD 21203. (301) 765-4339. *Circle 46.*

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CT-10 robotic wafer handler. Transports wafers of any size within a two-foot diameter. The 6×4×3-in. unit operates in a vacuum system. \$3,000. Advanced Control Engi-

neering, 3070 Lawrence Expressway, Santa Clara, CA 95051. (408) 730-4446. *Circle 51.*

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DSC5031 digital-to-synchro converter. Generates internal power from the reference input, and thus needs only a single-point ground to the system's logic ground. Prices start at \$710. Natel Engineering Company Inc., 4550 Runway St., Simi Valley, CA 93063. (805) 581-3950. *Circle 53.*

DSP-1000 software-development system. Helps programmers design algorithms for digital-signal-processing and image-processing applications. From \$42,000. Datcube Inc., 4 Dearborn Rd., Peabody, MA 01960. (617) 535-6644. *Circle 54.*

Dura-con microminiature connectors. These connectors are equipped with a solder cup, gold-plated solid wire, and insulated wire-lead terminations for cable-to-cable and cable-to-panel connections. \$6.20 to \$250.34 each in lots of 1,000. TRW Electronic Components Group, Connector Division, 1501 Morse Ave., Elk Grove Village, IL 60007. (312) 981-6000. *Circle 55.*

E-Series top-loading balances. Five rugged models for basic weighing functions. All have a six-in. liquid-crystal display. \$695 to \$1,095. Ohaus Scale Corp., 29 Hanover Rd., Florham Park, NJ 07932. (201) 377-9000. *Circle 56.*

Ektachem 700 chemistry analyzers. Three models: the 700S performs 26 colorimetric and potentiometric tests and eight urine chemistries. Model 700P offers 29 colorimetric and rate tests and six urine chemistries. The 700XR performs 33 rate, potentiometric

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Engineering modeling library. Lets engineers test structural designs for strength, safety, and performance. Works with the IBM PC/XT/AT or compatible computers. \$495 to \$3,990. Fujitsu America Inc., Information System Div., 3055 Orchard Dr., San Jose, CA 95134. (408) 434-9350. Circle 58.

Expert Controller diagnostic system. An expert system that detects problems in factory-automation systems. The product also offers advice on how to solve problems. \$5,500. UMEcorp, 700 Larkspur Landing Circle, Suite 299, Larkspur, CA 94939. (415) 925-2000. Circle 59.

Explorer II workstation. This symbolic processing system contains a 32-bit chip designed for artificial intelligence. The basic configuration includes eight megabytes of memory and a 140-megabyte hard disk. \$49,900 to \$99,900; a kit to upgrade earlier models costs \$20,000. Texas Instruments, Data Systems Group, Box 809063, DSG-141, Dallas, TX 75380. (800) 527-3500. Circle 60.

Feline-LT monitor/protocol analyzer. Plugs into a Toshiba Model 1100+ or 3100 laptop to handle such protocols as X.25, SNA, HDLC, SDLC, and BSC. Offers state analysis, triggering, counters, and analysis programming. \$1,895. Frederick Engineering Inc., 10200 Old Columbia Rd., Columbia, MD 21046. (301) 290-9000. Circle 61.

GaAlAs infrared-emitting diode. Provides 1.7 times the radiant output of gallium-arsenide equivalent devices. \$10.63 each in lots of 1,000. TRW Electronic Components Group, Optoelectronics Div., 15 W. Crosby Rd., Carrollton, TX 75006. (214) 323-2200. Circle 62.

IC Design engineering software. Working with the company's Analog Workbench computer-aided engineering package, this software analyzes the analog characteristics of linear, mixed-signal, and digital integrated circuits. \$8,000 to \$13,500. Analog Design Tools Inc., 1080 E. Arques Ave., Sunnyvale, CA 94088. (408) 737-7300. Circle 63.

Image-processing integrated circuits. In real time, these circuits process video images. Four versions come as standard products or as building blocks to create application-specific integrated circuits (ASICs). \$35

to \$695 each in lots of 500. LSI Logic, 1551 McCarthy Blvd., Milpitas, CA 95035. (408) 433-4226. Circle 64.

Laser ac-motor drive control. Produces adjustable frequency and voltage, plus three-phase output. Includes fault, short-circuit, and inverse-time-overload protection. \$2,300 to \$3,800. Emerson Industrial Controls, 3036 Alt Blvd., Grand Island, NY 14072. (716) 773-2321. Circle 65.

LD1100 bar-code decoder. Working with both laser and wand systems, this device automatically reads the nine most-used bar codes. \$495. Photographic Sciences Corp., Box 338, Webster, NY 14580. (800) 828-6489; in NY, (800) 828-3030. Circle 66.

LDK 90 ENG camera. Creates film-quality pictures. \$18,000. Broadcast Television Systems, Box 30816, Salt Lake City, UT 84130. (801) 972-8000. Circle 67.

Le Mans display system. Draws one million vectors/second for rapid generation of color graphics. Works with such host computers as VAX and Sun workstations. Chromatics, 2558 Mountain Industrial Blvd., Tucker, GA 30084. (404) 493-7000. Circle 68.

Magnetic Designer transformer-design program. Runs on an IBM PC to design bobbin-wound transformers with as many as 12 windings from 10 Hz to 500 KHz. \$295. Analytic Artistry, 3418 Garnet St., Torrance, CA 90503. (213) 542-3413. Circle 69.

Measure for Symphony data-collection program. Collects data from measurement instruments and incorporates it into the Symphony spreadsheet for analysis, storage, and graphic display. \$495. Lotus Development Corp., 55 Cambridge Parkway, Cambridge, MA 02142. (617) 577-8500. Circle 70.

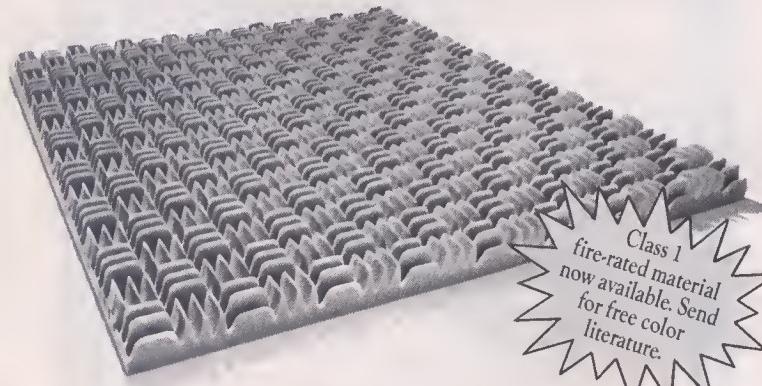
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Phone-conversation recorder. Works with any phone or tape recorder to automatically record a conversation when the receiver is lifted. Meets FCC requirements. \$24.95. Electronic Devices, 4900 87th Ave. N., Pinellas Park, FL 33565. (813) 544-1511. Circle 71.

R-115 stereo receiver. An AM/FM receiver that handles low impedance and offers remote control. The receiver also provides automatic fine-tuning. \$750. Luxman, 19145 Gramercy Place, Torrance, CA 95059. (213) 326-8000. Circle 72.

R4 stereo receiver. Allows dubbing between two tape decks while playing a third program source. Has 30 station-memory settings and a timer. \$1,100. Analog and Digital Systems, 1 Progress Way, Wilmington, MA 01887. (617) 729-1140. Circle 73.

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AMR	60	Equitable Real Estate	9
AST Research	29,60	Ergotron	60
AT&T	13,35,38,64	Executone	39
Adaptive Networks	64	Fanuc	18
Adept Technology	22	Financial Interchange	36
Admac	9	Florida Interchange Group	36
Advanced Control Engineering	61	Ford Aerospace	10,50
Akihabara	15	Ford Motor	42
Alltel	39	Fox Software	60
American Airlines	35	Frederick Engineering	62
American Express	35	Frost & Sullivan	34,54
American Motors	44	Fujitsu	34,39,60,62
American Superconductor	8	GCA	24
Analog Design Tools	62	GEF Automation	18
Analog Devices	61	GMF Robotics	18
Analytic Artistry	62	GTE	38,51
Analytichem International	60	General Automation	13
Apple	30,60	General Dynamics	11
Arch Development	8	General Electric	11,18,45
Argo Group	39	General Motors	18,42
Argonne National Laboratory	8	Groupe Bull	13
Arthur D. Little	35	Grumman	10
Audec	64	Hambrecht & Quist	13
Automatic Connector	61	Harvey Software	60
Auxton Computer	41	Hewlett-Packard	15,24,29
Avis	35	Hitachi	15
Ball	61	Hughes Aircraft	44
BayBanks Systems	36	Hyundai	44
Bell Communications Research	8	IBM	9,29,34,37
Boeing	10	Icot	35
Boole & Babbage	61	Image Technology	60
Booz, Allen, and Hamilton	10	Informart	9
Borland International	60	Inforum	9
British Telecom	41	Innovative Devices	64
Broadcast Television Systems	62	InsuranceQuote Services	60
CAP International	27	Intel	10,62
CIM	24	IntelleDEX	24
CXI	59	Interactive Machines	60
California Micro Devices	39,51	Interlink	35
Canon	28	International Rectifier	60
Cash Station	36	Iomega	59
Cellular Business Systems	41	Isuzu	45
Centel	39,49	JVC	15
Centigram	59	Jardine Fleming Ltd.	15
Central Trust	36	K Mart	35
China Great Wall Industry	11	Kanematsu-Gosho	24
Chromatics	62	Kawasaki	24
Chrysler Motors	22,44	LSI Logic	62
Cincinnati Bell	41	Litel Telecommunications	39
Cincinnati Milacron	22	Lockheed Missiles and Space Co.	10,50
Cirrus	34	Lotus	15,62
Communications Satellite	40	Lucky	37
Control Data	13	MCI	38
Creative Management Systems	41	MTech	36
DA Systems	8	Marantz	15
DMC	35	Martin Marietta	11
Daiwoo	44	MasterCard	34
Daisy Systems	61	Matsushita	15,24
Datacopy	29	Mellon Bank Network Services	36
Datacube	61	Mercedes-Benz	44
Dataquest	18,51	Microelectronics & Computer Technology	8
Datarol	35	Microsafe Products	59
Dest	30,59	Microtek	28
Diebold	34	Microtel	39
Digital Communications	15	Mita Copystar America	59
Digital Equipment	9	Money Access Service	36
Diversified Data Systems	61	Motorola	13,45,62
Docutel	35	NASA	10
Eastman Kodak	9,62	NBI	60
Electronic Data Systems	45	NCR	34
Emerson Industrial Controls	62	NEC America	59,60
Environmental Technology	61	Nachi-Fujikoshi	24
Epson	30	Natel Engineering	61
Equatorial Communications	40	National Business Systems	35
		National Machine Systems	62
		National Semiconductor	45
		Nationet	36
		Network Communications	59
		New Micros	59
		Nissan	44
		Northwest Switching System	36
		Norwest	36
		Ohaus Scale	61
		Okidata	60
		Omron	34
		POS News	35
		Panasonic	24,28
		Parallel Computers	13
		Philips and Du Pont Optical	9
		Photographic Sciences	62
		Planning Research	10
		Plus System	36
		Prab Robots	22
		Protel Communications	59
		Prudential-Bache Securities	18
		Pulse	34
		QL Tech	15
		Quasitronics	60
		RC Computers	13
		Recognition Equipment	59
		Rhone-Poulenc	9
		Ricoh	28
		Saba	30
		Salomon Bros.	38
		Sankyo Seiki	24
		Seiko Instruments	22,59
		Sharp	28
		Siemens AG	39
		Sony	15,64
		Southern New England Telecommunications	38
		Southwestern Bell	64
		Stratus Computer	13
		Suzuki	45
		Synergy Computer Graphics	61
		Sysgen	59
		System Software Associates	60
		TRW	11,50,61,62
		Taltek	35
		Tandem Computers	13,60
		Technology Information Products	60
		Telecom Australia	41
		Telegence	59
		Telesoft	50
		Texas Instruments	45,62
		The Complete PC	60
		The Portman Companies	9
		The Software Link	59
		Thunderware	30
		Tolerant Systems	13
		Toshiba	8,15
		Toyota	44
		Transitions Research	24
		Trinitron	64
		U.S. Imaging and Security	59
		UMECorp	62
		US Sprint Communications	38
		US Telecom	38
		United Telecommunications	38
		University Technology	11
		Verbatim	9
		Verifone	35
		Vicarm	22
		Visa	34
		Voice Industries	10
		Volvo	44
		Wendy's	37
		Westinghouse	10,18,61
		Wyle Lab	10

Office Aids for Executives

OFFICE

VCR fits on desktop

A NEW VCR from Sony is compact enough to fit on even the most cluttered desk. The EV-DT1, which costs about \$1,500, combines a VCR with a Trinitron color TV. On the five-inch, color screen, harried managers can watch TV shows or other prerecorded tapes without walking to the company's video room.

The player owes its diminutive size to its use of eight-millimeter tape, packaged in cassettes about the size of standard audio cassette tapes. Also, the product uses Sony's recently developed short-neck Trinitron picture tube, and is the first application of this new tube.

The desktop VCR's small size has one big drawback—most prerecorded video cassettes are only available in the larger, VHS-type tapes, not in eight-millimeter for-

mat. But Sony, an unabashed supporter of the smaller format, has plans to make its desktop VCR more attractive by mating it with a palm-sized color video camcorder. The company expects businesses to use this hybrid to produce "video memos" or take "video minutes" of business meetings. No release date has been announced for the camera, but Sony plans in 1988 to release a hand-held VCR/TV with a 2.7-inch liquid-crystal display and an eight-millimeter recorder/player. This device would let people view their "video memos" on the road.

Computers talk through wall outlets

EXECUTIVES who want a low-cost, low-hassle computer network should look into a new modem that lets personal computers communicate through wall sockets. Office workers can plug

a computer in, unplug it, move it, and plug it in again. It will still communicate with other personal computers that are equipped with an Adaptive Networks AN192 modem. That eliminates dedicated communication wiring.

The new modem, which transmits at an admittedly slow 19.2 kilobits/second, comes in two forms. As a three-by five-inch printed-circuit card, it's being aimed at computer makers who can build the feature into their machines. As an external unit called the AN192 Standalone, the modem sells for between \$155 and \$400, depending on quantity. Software for general-purpose communication is due in November.

Adaptive Networks' address is Box 1020, Kendall Square, Cambridge, MA 02142; phone (617) 497-5150.

HOME

New phone takes orders

VOICE-activated telephones have been novelty items for a couple of years, but a feature-packed model released this month by Southwestern Bell may have broader appeal. Voice-activated phones are programmed by their buyers to recognize a spoken name, and then automatically dial the telephone number associated with the name. The com-



New eight-millimeter VCR is at home in cramped quarters.



Voice phone is more than a conversation piece.

mand "mom," for example, could trigger the phone to dial a person's mother when spoken into the receiver.

Current models—such as the \$229 Command Dialer II from Audec of Saddlebrook, N.J., the \$200 Voice Dialer from Innovative Devices of Santa Clara, Calif., or even the \$1,645 cellular model from AT&T—can only be activated by the voice of their programmer and perhaps one or two other people. But St. Louis-based Southwestern Bell claims its FV-1000 Freedom Phone, which retails for \$450, will dial in response to anyone's voice.

The FV-1000 has no number pad for manual dialing. To reach numbers not stored in its memory of frequently called people, the phone recognizes spoken numbers for voice dialing.

The FV-1000 is available through Southwestern Bell, 1000 Des Peres Rd., Suite 100, St. Louis, MO 63131; call (314) 822-6788.

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